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SCHUYLKILL RIVER BASIN
TUMBLING RUN, SCHUYLKILL COUNTY
PENNSYLVANIA
ID NO. PA.00688

LOWER TUMBLING RUN DAM

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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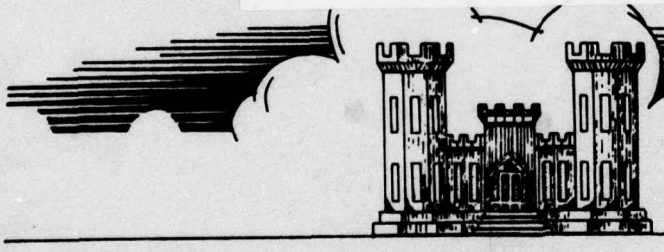
Contract No. DACW31-78-C-0048



DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

AUGUST 1978

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LEVEL II

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SCHUYLKILL RIVER BASIN

LOWER TUMBLING RUN DAM
SCHUYLKILL COUNTY, PENNSYLVANIA
NATIONAL I.D. NO. PA 00688

6

National Dam Safety Program. Lower Tumbling Run Dam (National I.D. Number PA-00688), Schuylkill River Basin, Schuylkill County, Pennsylvania. Phase I Inspection Report.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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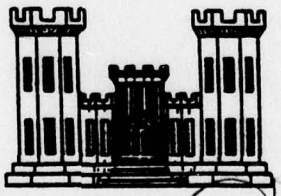

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Prepared by:

WOODWARD-CLYDE CONSULTANTS
5120 Butler Pike
Plymouth Meeting, Pennsylvania 19462

Submitted to:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

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August 1978

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JOB

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Lower Tumbling Run Dam
County Located: Schuylkill County
State Located: Pennsylvania
Stream: Tumbling Run Creek
Coordinates: Latitude 40° 40.5' Longitude 76° 10.9'
Date of Inspection: 4 August 1978

Lower Tumbling Run Dam, ~~is~~ owned by the Schuylkill Haven Borough, ~~and~~ is used as a water supply structure for the town of Schuylkill Haven and surrounding areas. Limited records indicate that the dam was constructed in 1832 and ~~was~~ completed in 1833. The dam failed in 1850 as a result of overtopping and again in 1869, as a result of a leak through water supply pipes embedded in the embankment. The facility is judged to be in fair condition although the embankment slopes are considered to be steep. Furthermore, the condition of the outlet works is unknown.

Hydrologic and hydraulic calculations indicate that overtopping of the dam will occur at approximately 30% ~~thirty percent~~ of the probable maximum flood. ~~(PMF)~~ Therefore, the spillway is considered to be 'Seriously Inadequate'.

The dam is classified as an 'Intermediate' structure by virtue of its forty-nine foot height, ~~It is classified~~ and as a 'High' hazard dam consistent with a potential at failure for extensive property damage, and loss of life at the water treatment plant and further downstream at Mount Carbon, Pennsylvania.

A review of the records indicates that there is insufficient engineering and construction data to adequately evaluate the stability of the dam and condition of the outlet works. Specifically, there was no substantial data delineating the types of material used in the embankment nor were there sufficient details to determine foundation conditions. Furthermore, the outlet system could not be inspected.

The following recommended remedial work is considered critical and should be performed immediately.

1. The spillway system should be reconstructed to meet current hydrologic/hydraulic criteria.

2. Prepare As-Built drawings in conjunction with a geotechnical investigation and stability analysis performed under the direction of a registered professional engineer. See Section 7 for details.

3. The outlet works sould be inspected and repaired as necessary.

The following items are considered important and should be performed as soon as practical.

1. Clear underbrush from the abutments to facilitate visual inspections for seepage.

2. Install seepage measuring devices. Monitor and record rates of flow and changes in turbidity.

3. Repair the riprap on the upstream slope.

A formal operation and maintenance procedure together with a warning procedure should be established and incorporated into the water treatment facilities operations manual. The warning procedure should include a method of warning downstream residents that high flows are to be expected. Evacuation procedures should also be developed.

The Owner should also develop an inspection checklist as an amendment to the maintenance procedure to insure that all items are inspected and maintained on a periodic basis.

John H. Frederick, Jr., P.E.
Maryland Registration 7301
Woodward-Clyde Consultants

9/22/78
Date

W S Gardner

William S. Gardner, P.E.
Pennsylvania Registration 4302E
Woodward-Clyde Consultants

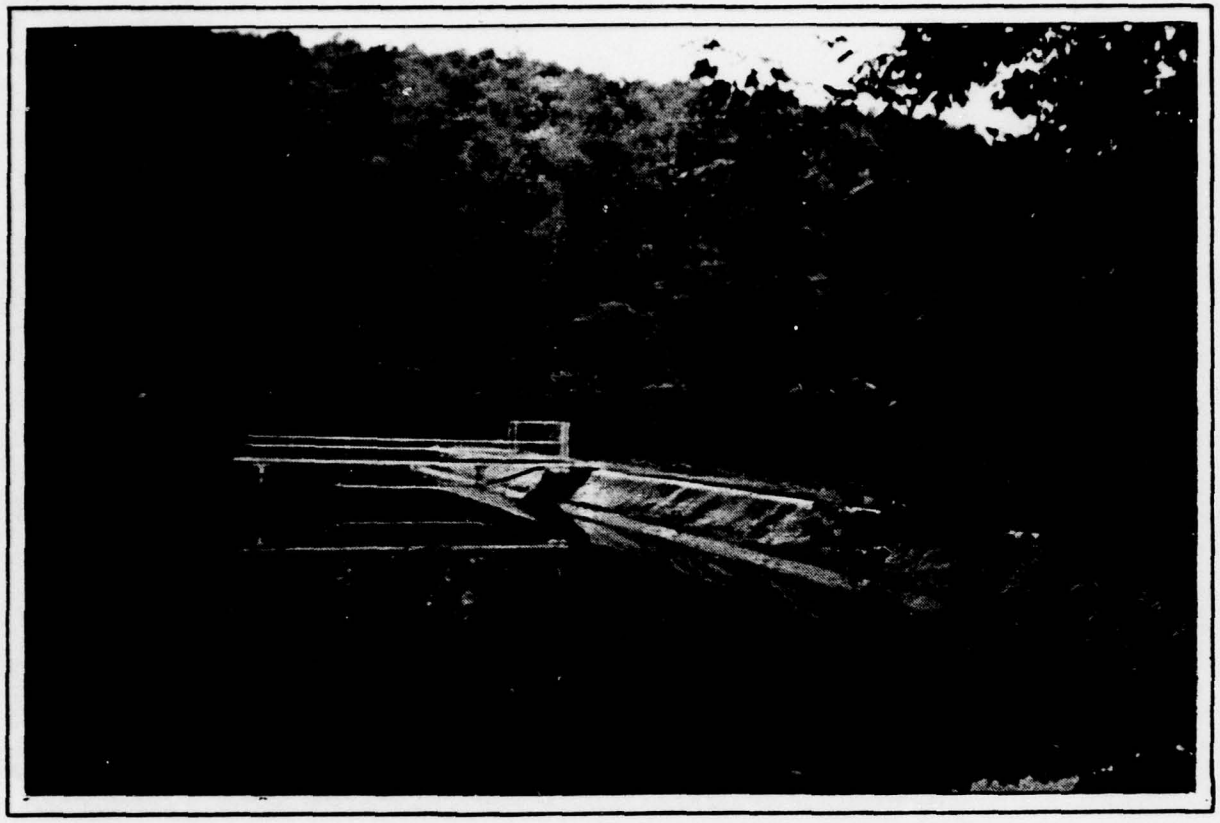
9/22/78
Date

APPROVED BY:

28 Sep 78
Date

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

Under the recently revised spillway evaluation guidelines, this dam is considered unsafe, non-emergency.



OVERVIEW
LOWER TUMBLING RUN, SCHUYLKILL COUNTY, PENNSYLVANIA

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
LOWER TUMBLING RUN DAM
NATIONAL ID #PA 00688
DER ID #54-24

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Lower Tumbling Run Dam is a 49 foot high earth dam across Tumbling Run Creek. The structure is 430 feet long with a 10 foot wide crest that impounds a 25.7 acre reservoir. The upstream slope from the crest to the waterline was observed to be approximately 0.5H:1V. The downstream slope measures approximately 1.5H:1V.

The outlet works consist of three 12-inch I.D. cast iron pipes which extend through the dam. The pipes are located approximately 42 feet below the dam crest. Two of the pipes carry water directly into the water treatment plant located immediately downstream of the dam. The third pipe extends downstream and can be used to drain the reservoir. The water supply intake structure is located within the upstream embankment and contains a 20-foot high semi-circular masonry approach channel wall. An access bridge has been constructed from the dam to a riser structure which houses the valves controlling the discharge of the three pipes. A plan and profile of the outlet works is presented in Appendix E as Plate 3. A sketch of the intake structure is presented in this report as Plate 5. This data was obtained from the Owner's representative.

Excess water is stored in the reservoir to elevation 646.5 and thereafter is discharged over the spillway. This spillway is located at the left abutment of the dam, and it is 55 feet long.

b. Location. The dam is located on Tumbling Run Creek in North Manheim Township, Schuylkill County, Pennsylvania. The embankment is located 2,600 feet downstream of Upper Tumbling Run Dam. The dam site and reservoir are

shown on USGS Quandrangle entitled, "Pottsville, Pennsylvania", at coordinates N 40° 40.5' W 76° 10.9'. A Regional Location Plan is enclosed as Plate 1, Appendix E.

e. Size Classification. The dam is classified as "Intermediate" by virtue of its 49-foot height.

d. Hazard Classification. A "High" hazard classification is assigned consistent with the potential for extensive property damage and loss of life downstream at the water treatment plant and in the town of Mount Carbon, Pennsylvania.

e. Ownership. The dam is owned by the Schuylkill Haven Borough located at 39 Dock Street, Schuylkill Haven, Pennsylvania.

f. Purpose of Dam. The dam was initially constructed to augment water supply for the Schuylkill Navigation Company canal, but has been used since 1908 for water supply.

g. Design and Construction History. Records concerning the design and construction of the dam could not be found and are no longer believed to exist. Limited post-construction documents report that the dam was constructed in 1832 for the Schuylkill Navigation Company. Records indicate that the construction began under the direction of Mr. George Duncan, but was completed in 1833 by an unknown contractor.

The dam failed in 1850. There was considerable damage and the reported loss of one life. The failure is reported to have been caused by a temporary weir constructed across the spillway weir in an attempt to store additional water. However, as a result of the dam being overtopped, a significant portion of the embankment was washed out. The dam was rebuilt in the same year by Colonel Knoderer.

Before 1869, the water supply pipes were always under full hydrostatic head. These pipes apparently cracked and the resulting leakage was large enough to cause piping and eventual embankment failure in 1869. As shown on Plate 4, the top of the dam dropped 10 feet. The pipes were repaired, encased in concrete for part of their length, and the valves moved to the upstream end of the pipes.

In 1909, the control valves were replaced, vertical riser pipes were added to the intakes, and an excavation was made in the embankment to investigate possible seepage along the outlet pipes. No evidence of seepage was found. The material excavated from the embankment was reported to be a mixture of yellow clay and gravel.

A tile drain system was installed in about 1961 and is located at the toe of the dam. Portions of the drain can be seen near the left abutment.

h. Normal Operating Procedures. Water is normally discharged through pipes extending through the dam into the water supply treatment facilities located

immediately downstream of the dam. The quantity discharged is dependent upon water supply demand. Excess water is discharged over the spillway into Tumbling Run Creek.

1.3 Pertinent Data.

A summary of pertinent data for Lower Tumbling Run Dam is presented as follows:

1.	Drainage Area (sq. miles)	6.0
2.	Discharge at Dam Site (cfs)	
	Spillway	2,200
	Outlet Works	Not determined.
3.	Elevations (feet above MSL)[1]	
	Top of Dam	653.0
	Spillway	646.5
	Max. Pool of Record	651.3
4.	Reservoir (miles)	
	Length at Normal Pool	0.5
	Fetch at Normal Pool	0.5
5.	Storage (acre-feet)	
	Normal Pool	531
	Top of Dam	698
6.	Reservoir Surface (acres)	
	Normal Pool	25.7
7.	Dam Data	
	Type	Rolled earth with riprap covering the upper portion of upstream slope and completely covering downstream slope.
	Length	430 feet
	Maximum Height	49 feet
	Top Width	10 feet
	Side Slopes (approximate)	
	Upstream	1.3H:1V, measured.
	Exposed Riprapped Portion	Unknown
	Below Water Level	
	Downstream	1.6H:1V, measured.

8. Spillway

Type	Broad crested concrete and rock weir.
Length	55 feet
Elevation(1)	646.5

(1) Estimated from USGS Mapping and available drawings.

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Data Available. A summary of engineering data is presented on the checklist attached as Appendix A. Principal documents containing data used for this report are as follows.

1. "Report Upon the Investigation of the Philadelphia & Reading Coal & Iron Company Dams On Tumbling Run, Schuylkill County, Pennsylvania", by the Water Supply Commission of Pennsylvania, dated December 22, 1913.

2. "Report Upon the Tumbling Run Supply of the Silver Creek Water Company", by the Water Supply Commission of Pennsylvania, dated November 12, 1920.

3. Letter to Water and Power Resources Board, Department of Forests and Waters, Harrisburg, Pennsylvania, from the Silver Creek Water Company, by Mr. H. W. Weber, dated April 9, 1935.

4. "Investigation of Tumbling Run Dams, W.O. 6338-00", by Gilbert Associ-ates, Inc., Reading, Pennsylvania, dated March 1, 1967.

5. Miscellaneous letters, correspondence, memos, drawings and inspection reports located in the Department of Environmental Resources (DER) main office in Harrisburg, Pennsylvania.

The data consisted of post-construction reports and investigations of the dam. Documents regarding the design and construction could not be found and are no longer believed to exist.

b. Design Features. The principal design features are illustrated on the plan and cross-section plates enclosed in Appendix E as Plates 2 and 3. These plates were reproduced from drawings located in the DER files. A brief description of the design features is also presented in Section 1.2, "Description of Project".

The dam is an earth embankment with riprap on the downstream slope and the upper 15 feet of the upstream slope. There are various reports of the upstream and downstream slope inclinations. A summary of the reported slope inclinations is included in Table 1.

TABLE I
SUMMARY OF REPORTED SLOPE INCLINATIONS

Upstream Slope	
Crest of dam to bottom of riprap	
Water Supply Commission, 1913	0.5H:1V
Silver Creek Water Company, 1935	1H:1V
Below riprap	
Cross Section of Embankment, 1869, Plate 4	2.25H:1V
Plan Showing Valves and Outlet, 1908, Plate 3	2.6H:1V
Water Supply Commission, 1913	2.6H:1V
Silver Creek Water Company, 1935	2.6H:1V
Gilbert Associates, Inc., 1967	2.25H:1V
Downstream Slope	
Cross Section of Embankment, 1869, Plate 4	1.625H:1V
Plan Showing Valves and Outlet, 1908, Plate 3	1.6H:1V
Water Supply Commission, 1913	1.6H:1V
Silver Creek Water Company, 1935	1.6H:1V
Gilbert Associates, Inc., 1967	1.625H:1V
Visual Inspection, 1978	1.5H:1V

Field measurements made during the visual inspection performed for this report indicate a downstream slope of 1.5H:1V and an upstream slope above the water level of 1.3H:1V, slope of grouted riprap. The crest of the dam was measured to be 430 feet long with a 10 foot wide crest. Seepage control is apparently minimal and consists of reported tile toe drains at the base of the dam.

2.2 Construction.

The earliest report of the construction history is documented in a Water Supply Commissions report dated December 22, 1913. This report states that the construction was performed for the Schuylkill Navigation Company. Construction began in 1832 by Mr. George Duncan, but was completed in 1833 by an unknown constructor. Materials used are reported to have been decomposed shale. Information about soil properties and construction techniques were not included in the files. All other records describing post-construction changes and investigations are described in Section 6.

2.3 Operation Data.

The only records currently being maintained are those related to the water supply treatment facilities. Discharge from the treatment facilities are recorded, but flows over the spillway are not.

2.4 Evaluation.

a. Availability. All information presented herein was extracted from records located in the Department of Environmental Resources files in Harrisburg, Pennsylvania or from conversations with the Owner's representative. Design and construction data could not be located.

b. Adequacy. The available data included in the State files and presented in this report are not adequate to evaluate the engineering aspects of the dam.

c. Validity. There are several discrepancies in the post-construction reports which require verification. A significant amount of required data is nonexistent and must be determined to evaluate this dam.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The observations and comments of the field inspection team are contained in the checklist enclosed herein as Appendix B and are summarized and evaluated as follows. In general, the appearance of the facility indicates that the dam is currently in good condition.

b. Dam. During the visual survey, there were no indications or evidence of distortions in alignment. Minor grade differences were noted along the dam crest as the result of settlement. There were no surface cracks or sloughing observed. The upstream and downstream riprap was in good condition and stable. The upstream riprap has been grouted with pneumatically placed mortar. Some erosion was noted on the upstream slope below the riprap protection.

A slight quantity of seepage was observed through the valve chamber located at the downstream toe on the right side of the dam. Seepage was also noted through an observation well at the toe near the left abutment. This flow is probably the seepage through the French (tile) drain system reported by Gilbert Associates, Inc., in 1967. Location of the observed seepage is shown on Sheet 5a, Appendix B.

c. Appurtenant Structures.

1. Outlet Works. The intake structure and cast iron pipes were submerged during the visual inspection and could not be inspected. The access bridge to the intake valves consists of a steel frame structure with wood planking. The concrete supports of the bridge were noted to have a number of cracks, but appeared to be stable. It was reported by Mr. Charles Feindler, Borough Manager, that the intakes for the vertical riser pipes are approximately 7, 14 and 22 feet above the base of the intake structure. They are connected to three 12-inch diameter cast iron pipes. See Plate 5 for details.

A masonry arch valve chamber is located at the toe of the downstream slope. There are valves on each of the three pipes, but they are no longer used and are submerged. A small quantity of clear water was noted flowing from this area, which may be seepage and/or leakage from these valves. The two outer pipes are connected to the treatment plant and are currently used for water supply. The third pipe (center) discharges approximately 100 feet downstream through a valve. Leakage was observed at this valve.

2. Spillway. The spillway has been excavated into rock at the left abutment and was observed to be in good condition. The right side of the channel adjacent to the dam consists of a concrete retaining wall, which changes to a masonry wall beyond the dam. The left side of the channel has been excavated into

rock. Some rock spalling and broken rock was observed in the spillway. The spillway bottom is very irregular (See Photographs 6 and 7). Brush and some woody vegetation was noted to be growing in the spillway, but does not currently constitute an obstruction to flow.

d. Reservoir. Reconnaissance of the reservoir disclosed no evidence of significant siltation, slope instability, or other features that would significantly affect the storage capacity of the reservoir. The reservoir side slopes are steep, well vegetated and stable.

e. Downstream Channel. Flows from the spillway are directed into a 15 foot wide man-made channel. Portions of the channel are lined with hand-placed rock. Flows from the vicinity of the valve house are channeled into a narrow stream bed, and directed into a catch basin. Thereafter, the flow merges with the spillway channel. See Section 5 for more details of the downstream channel.

3.2 Evaluation.

In summary, the visual survey of the dam disclosed no evidence of existing instability of the dam. However, the steepness of the downstream slope and seepage, along with the age and leakage of the outlet works, are considered items of concern. Therefore, additional investigation and evaluation is recommended as described in Section 7.

SECTION 4
OPERATION PROCEDURES

4.1 Procedures.

Water is drawn from the reservoir on demand into the water treatment plant via two 12-inch pipes. Excess water discharges over the emergency spillway at elevation 646.5. The only records maintained are water supply discharges through the treatment facilities.

4.2 Maintenance of the Dam.

The dam is maintained by the Schuylkill Haven Borough and is periodically checked by the Department of Environmental Resources. There is no operational manual other than the operating procedures for the water treatment facility. Very little maintenance was performed in recent years. The upstream riprap was grouted in the early 1960's.

4.3 Maintenance of Operating Facilities.

Maintenance of the appurtenances is performed by the Schuylkill Haven Borough. However, valves outside of the treatment facility are not readily accessible and have received little maintenance over the years. The pipes downstream of the dam toe are being replaced as well as expansion of the treatment facilities. Woody vegetation is periodically removed from the spillway.

4.4 Warning Systems in Effect.

There are no formal warning systems or procedures established to be followed during periods of exceedingly heavy rainfall. The dam is checked almost daily for unusual conditions. It is understood that responsible people are always in the area and available if a potentially hazardous condition develops. In the event of an emergency, the local Civil Defense Authority would be notified. The Borough Manager stated that the city representatives are stationed at the dam during periods of heavy rainfall.

4.5 Evaluation.

No written operating procedures exist, but should be developed and integrated with the procedures of the treatment facilities. Maintenance procedures should be developed and incorporated into the operating procedures of the treatment facilities, and include a checklist of items to be observed during inspection of the dam and outlet works.

Since a formal warning procedure does not exist, a formal procedure should be developed and implemented during periods of extreme rainfall. This procedure should consist of a detailed method for notifying personnel working in the treatment plant and residents downstream.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features.

a. Design/Evaluation Data. There was no original design data available. Two inspection reports, one by C. E. Ryder of The Water Supply Commission of Pennsylvania, dated 22 December 1913, and one by H. T. Newton of Gilbert Associates, Inc., dated 1 March 1967, were in the State files. All other data was obtained from these reports, and from several drawings, many untitled and undated, supplemented with field observations. Upper Tumbling Run Dam is also the subject of inspection under the National Dam Inspection Program, and the results of the hydrologic/hydraulic analysis are incorporated in this section.

The watershed is small, approximately 6.0 square miles, and roughly rectangular, lying between parallel ridges 0.9 to 1.0 miles apart. The upper end is about 6.5 miles above the dam, at an elevation near 1,100 feet. The normal reservoir pool is at approximately elevation 646.5. The ridges run from elevation 1,200 to 1,400. The watershed is primarily owned by the Schuylkill Haven Borough. It is steep, rocky and densely wooded.

The earth fill dam extends across the valley and has a crest elevation of approximately 653.0 feet. Since there were no surveys since 1929, the datum relative to MSL could not be determined. Therefore, all elevations were estimated from USGS mapping.

The operating outlet works consist of three 12-inch pipes, valved at the upper end, passing under the dam into the water treatment plant at the downstream toe. Their flows are hydrologically insignificant.

The spillway is an irregular channel cut through rock in the left abutment. A broad crested concrete control sill extends across all but about 10 feet of the crest. The crest length is 55 feet at an elevation of approximately 646.5. Below the crest, the rough rock channel slopes 6 to 8 percent and narrows, but not enough to impede flow over the crest. The spillway is capable of discharging approximately 2,200 cfs with the water level at the top of the dam (See Appendix C).

Upper Tumbling Run Dam is located 1/2 mile above Lower Tumbling Run Dam. Of the 6 square miles of watershed, 5.5 square miles contribute first to Upper Tumbling Run Dam, with only 0.5 square miles contributing directly to Lower Tumbling Run Reservoir. Consequently, the principal flood inflow is the discharge from the upper reservoir.

In accordance with the criteria established by the Federal (OCE) Guidelines, the recommended spillway design flood for this "Intermediate" size dam with a "High" hazard potential is the probable maximum flood (PMF).

b. Experience Data. According to the Owner's representative, the worst flood of record occurred during Tropical Storm Agnes, on June 22 and 23, 1972. This rainfall produced a maximum water elevation in Lower Tumbling Run Reservoir of 651.3. This corresponds to 4.8 feet of flow over the spillway.

c. Visual Observations. On the date of inspection, no conditions were observed to indicate reduction of spillway capacity during maximum discharge. Observations regarding the downstream channel, spillway conditions, and reservoir are located in Appendix B.

d. Overtopping Potential. Maximum outflow without failure from Upper Tumbling Run is approximately 2,200 cfs (Sheet 5, Appendix C). This corresponds to an inflow into the upper dam of 30 percent of PMF (Sheet 9, Appendix C).

The spillway of this dam, while rated the same as the upper one, is both wider (55 feet as opposed to 52 feet) and a little deeper (6.5 feet below crest as opposed to 6.2 feet), and it is judged capable of handling the added local inflow from the 30 percent PMF without overtopping.

Inflows exceeding 30 percent of the PMF, however, will result in overtopping and failure of Upper Tumbling Run Dam (see Sheet 6, Appendix C).

e. Spillway Adequacy. The spillway system is judged "Seriously Inadequate" as all of the following conditions exist (Engineering Technical Letter No. 1110-2-234, 10 May 1978):

> "1. There is high hazard to loss of life from large flows downstream of the dam.
>
> "2. Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.
>
> "3. The dam and spillway are not capable of passing one-half of the probable maximum flood without overtopping failure."

Item 1 is covered in the following subsection and item 3 is covered above. Overtopping of Upper Tumbling Run Dam would result in its failure, which would inevitably lead to the failure of Lower Tumbling Run Dam, 1/2 mile downstream. Failure of Lower Tumbling Run Dam will either cause the downstream railroad embankment to fail or massively overtop, increasing the damage downstream over what would occur from the maximum spillway discharge. Therefore, the spillway is "Seriously Inadequate".

f. Downstream Conditions. About 1,200 feet below Lower Tumbling Run Dam, the valley is blocked by an abandoned multi-track railroad earth embankment, and a multi-lane highway at a lower level on the downstream side. Tumbling Run,

below the dams, passes under the combined railroad and highway embankment through a culvert. The culvert is approximately 10 by 18 feet at its smallest section. The embankment is estimated to be 35 to 40 feet above the invert of the culvert on the upstream side. The creek joins the Schuylkill River in the town of Mount Carbon, Pennsylvania just below the tunnel outlet.

The capacity of the culvert, with 25 feet of water backed up behind the embankment, is about 5,800 cfs (Sheet 8, Appendix C). Storage behind the embankment appears to be about a quarter of the capacity of either dam. Consequently, while the culvert would most likely pass a PMF outflow through larger spillways, it would clearly massively overtop in a failure, which is likely with any inflow over 30 percent of PMF.

There are three buildings between Lower Tumbling Run Dam and the embankment that are possibly subject to damage in the event of large flows from the dam. These buildings would be destroyed, with possible loss of life, in the event of dam failure. In the event of dam failure and embankment failure, there are also several industrial buildings and houses in Mount Carbon and along the Schuylkill River which would be damaged or destroyed, justifying the "High" hazard classification.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. The visual observations did not indicate any existing embankment stability problems. However, the downstream slope and observed portion of the upstream slope are unusually steep. Some slight erosion was noted upstream at the base of the riprap zone. Seepage was observed in the French drain system and valve leakage or embankment seepage was observed through the valve chamber. The seepage was clear and there were no indications of piping. The spillway was in good condition with stable channel sides, although some channel and wall spalling was noted. Woody vegetation was also noted.

b. Design and Construction Data. No design or construction data is known to exist. All data concerning physical features of the dam have been determined by post-construction investigations, and judged to be inadequate for a detailed evaluation of the dam.

c. Operating Procedures. The only procedures established have been for the operation of the water treatment facility.

d. Post-Construction Changes. Major repairs to this dam were required in 1850 and 1869 as the result of failures, as described in Section 1. Normal maintenance and valve replacement was done in 1906. The dam was the subject of investigation by the State in 1913 and 1920. In 1913 the reservoir was emptied in order to inspect the outlet pipes, which were found to be in good condition. No repairs or alterations were recommended in either report. In 1967 Gilbert Associates, Inc., was hired to investigate both Upper and Lower Tumbling Run Dams. No repairs or modifications were recommended for Lower Tumbling Run (although further investigation was recommended for Upper Tumbling Run Dam).

Currently, the water treatment facility is being renovated and expanded. This work has been designed by Gilbert Associates, Inc.

e. Seismic Stability. This dam is located in Seismic Zone 1. Normally, it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake conditions. Since the static factor of safety for this dam is unknown, a seismic stability evaluation could not be made. Considering the steepness of the existing slopes, it is concluded that safety factors under both static and seismic loading should be evaluated.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. The visual inspection indicates the dam is generally in fair condition. There is no engineering or construction data other than information obtained from post-construction investigations. The downstream slope is steep and would not meet current standards of practice. The outlet works are 109 years old and may be near the end of their service life. The spillway capacity is judged to be "Seriously Inadequate" using the Corps of Engineers criteria. A relatively small amount of seepage has been occurring over a significant period of time, and although it has not caused any problems since the failure of 1869, the flow should be monitored for changes in flow rates and turbidity.

Upper Tumbling Run Dam was also inspected under the National Dam Inspection Program. Results of that investigation indicate the spillway to be "Seriously Inadequate". The dam would fail in the event of overtopping, which is estimated to occur at approximately 30 percent PMF.

b. Adequacy of Information. Insufficient engineering and construction data was found to adequately evaluate the stability of the dam and service life of the outlet works. Specifically, there is no substantial data delineating the types of materials and configuration of the embankment. Foundation preparation details are also unknown. Details of the outlet works were available only from photographs.

c. Urgency. It is concluded that the recommendations considered to be critical in Section 7.2 be implemented immediately. All other items should be implemented as soon as practical.

7.2 Remedial Measures.

a. Facilities. The following recommended remedial work is critical and should be performed immediately.

1. The spillway system should be reconstructed to meet current hydrologic/hydraulic criteria.

2. Prepare "As-Built" drawings in conjunction with a geotechnical investigation and stability analyses. Piezometers should be installed in the embankment to measure the phreatic surface.

3. The outlet works should be inspected and repaired, if necessary.

The following items are considered important and should be performed as soon as practical.

1. Clear underbrush from abutments to facilitate visual observations for seepage.

2. Install seepage measuring devices/structures, and monitor and record rates of flow.

3. Repair the riprap on the upstream slope.

b. Operation and Maintenance Procedures. Formal operations, maintenance, and warning procedures should be developed and incorporated into the water treatment facility's operation. The warning procedure should include a method of warning downstream residents that high flows are to be expected. Evacuation procedures should also be developed.

The Owner should also develop an inspection checklist as an amendment to the maintenance procedure to insure that all critical items are inspected and maintained on a periodic basis.

APPENDIX

A

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Lower Tumbling Run Dam

ID # PA 00688

ITEM	REMARKS
AS-BUILT DRAWINGS	None. One drawing was made following the failure of 1869 and consisted of an embankment profile along with the outlet works. A plan and profile drawing prepared in 1908 was found in the files along with several plans of the reservoir but may not be As-Built plans.
REGIONAL VICINITY MAP	Unmarked plans of Lower and Upper Tumbling Run Reservoirs.
CONSTRUCTION HISTORY	Post-construction investigations included limited construction history which is presented in the text of this report.
TYPICAL SECTIONS OF DAM	"Cross-Section of Embankment", July 19, 1869. Plan Showing Valves and Outlet, dated August, 1908.
OUTLETS - PLAN	Limited and conflicting data included on drawings; "Cross-Section of Embankment", July 19, 1869. Plan Showing Valves and Outlet, August, 1908.
DETAILS	
CONSTRAINTS	
DISCHARGE RATINGS	None
RAINFALL/RESERVOIR RECORDS	None

ITEM	REMARKS
DESIGN REPORTS	*None*
GEOLOGY REPORTS	*None*
DESIGN COMPUTATIONS	*None found.*
HYDROLOGY & HYDRAULICS	*Summaries presented in post-constrution investigations.*
DAM STABILITY	*None found.*
SEEPAGE STUDIES	*None found.*
MATERIALS INVESTIGATIONS	
BORING RECORDS	*None found.*
LABORATORY	
FIELD	
POST-CONSTRUCTION SURVEYS OF DAM	*"Cross-Section of Embankment", July 19, 1869.*
BORROW SOURCES	*Unknown*

ITEM	REMARKS
MONITORING SYSTEMS	*None*
MODIFICATIONS	*Dam essentially rebuilt following failure in 1850. Section containing outlet works rehabilitated after failure in 1869. New valves installed at intake of 12 inch I.D. pipes, 1909. Riser pipes added, unknown date.*
HIGH POOL RECORDS	*None*
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	*The following post-construction studies are known to have been made and included in the DER files:* *1. "Report Upon the Investigation of the Philadelphia & Reading Coal & Iron Company Dams on Tumbling Run, Schuylkill County, Pennsylvania", by the Water Supply Commission of Pennsylvania, dated December 22, 1913, and supplementary reports of 1914.-----(Continued on Sheet 4 of 4).*
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	*Yes, two failures have occurred.* *Included in post-construction reports.* *No specific reports.*
MAINTENANCE OPERATION RECORDS	*None*

ITEM	REMARKS
SPILLWAY PLAN	*None*
SECTIONS	*None*
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	*"Plan Showing Valves and Outlet", August, 1908.*
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS--*CONTINUED FROM SHEET 3 of 4*	2. *"Report Upon the Tumbling Run Supply of the Silver Creek Water Company", by the Water Commission of Pennsylvania, dated November 12, 1920.* 3. *Letters to Water and Power Resources Board, Department of Forest and Waters, Harrisburg, Pennsylvania from the Silver Creek Water Company by Mr. H.W. Weber, dated April 9, 1935.* 4. *"Investigation of Tumbling Run Dams, W.O. 6338-00", by Gilbert Associates, Inc., Reading, Pennsylvania.*

APPENDIX

B

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam *Lower Tumbling Dam* County *Schuylkill* State *Pennsylvania* National ID # *PA 00688*

Type of Dam *Rolled Earth* Hazard Category *I (High)*

Date(s) Inspection *4 Aug. 1978* Weather *Rain, Cloudy* Temperature *70's*

Pool Elevation at Time of Inspection *644.3* M.S.L. Tailwater at Time of Inspection *None* M.S.L.

Inspection Personnel:

Brady Bisson (Geotechnical)
John Boschuk, Jr. (Geotechnical/Civil)
John H. Fredrick, Jr. (Geotechnical) *(1 Aug. 1978)*
Vince McKeever (Hydrologist)
Ralph H. Cross (Hydrologist)

John Boschuk, Jr. Recorder

Remarks:

Mr. Dick Nagle, Chief Operator and Mr. Kenny Frehafer, Borough Manager were onsite and provided information during the inspection.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	*N/A*	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	*N/A*	
DRAINS	*N/A*	
WATER PASSAGES	*N/A*	
FOUNDATION	*N/A*	

CONCRETE/MASONRY DAMS

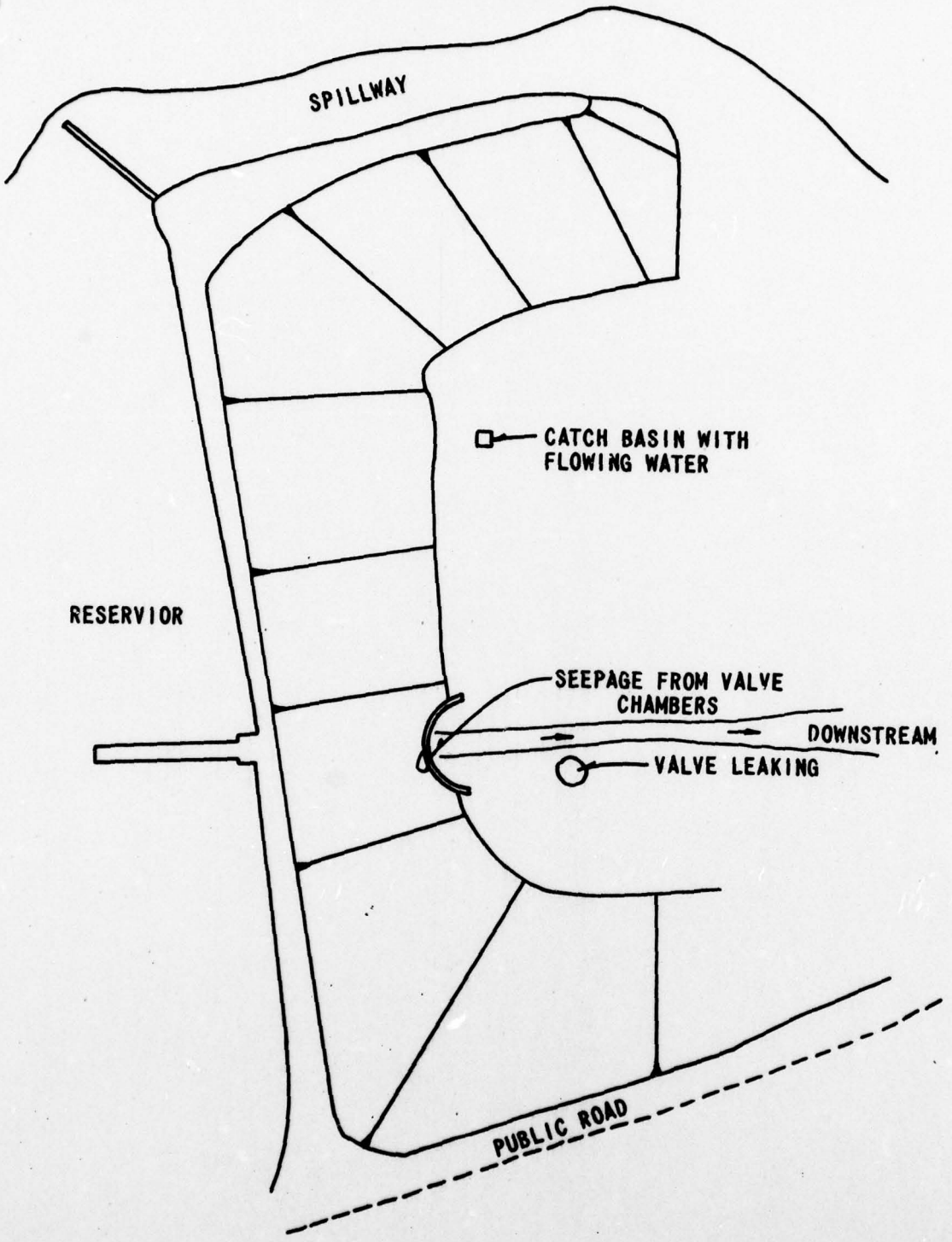
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	*N/A*	
STRUCTURAL CRACKING	*N/A*	
VERTICAL AND HORIZONTAL ALIGNMENT	*N/A*	
MONOLITH JOINTS	*N/A*	
CONSTRUCTION JOINTS	*N/A*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	*None observed.*	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	*None observed.*	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	*Some slight slope discontinuities were observed on the downstream slope but were assessed to be associated with adjustment of the riprap protection and not slope failure.*	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	*The vertical and horizontal alignment is good with no misalignments observed. The crest was noted to be slightly irregular as a result of settlements.*	
RIPRAP FAILURES	*None observed but some slight slope adjustments were observed. The upstream riprap was covered with grout. Wave action is washing out soil and/or rock along sections at the base of the rock. See Photograph No. 9.*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	*All junctions were in good condition.*	
ANY NOTICEABLE SEEPAGE	*Yes. See sheet 5a of 11 for details. A slight amount of seepage was noted at the valve chamber. A catch basin was also observed near the downstream toe which contained water and appears to be connected to a french drain system.*	
STAFF GAGE AND RECORDER	*None*	
DRAINS	*Yes. The french drain below the dam toe is presently covered and serves as a parking area but there are two existing brick access boxes, catchbasins, where the seepage can be observed. The flow was clear.*	



SEEPAGE LOCATION PLAN
LOWER TUMBLING RUN DAM

SHEET 5a OF 11

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	*Cast iron pipes lead from the upstream toe through the embankment and are underground below the downstream toe. These pipes could not be inspected.*	
ACCESS BRIDGE SUPPORT	*The portions of the concrete bridge supports the water surface were observed to contain a number of cracks and should be replaced. See Photo. No. 10.*	
INTAKE STRUCTURE	*The structure is under water and could not be inspected. The gate at the end of the bridge was locked and the valves were not exercised. Valves of two pipes being used for water supply remain in the open position with all valves of the third pipe closed.*	
OUTLET STRUCTURE	*N/A*	
OUTLET CHANNEL	*None*	
EMERGENCY GATE	*Pond drain valve was closed at three locations along the line. It was not exercised. Leakage was noted at the downstream outlet valve.*	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	*The broad crested concrete weir was poured directly onto the rock foundation and is in generally good condition. See Photograph 5.*	
APPROACH CHANNEL	*The approach channel is cut through natural material as shown on Photograph 4. It is stable and in generally good condition.*	
DISCHARGE CHANNEL	*The channel is cut into natural rock and is extremely rough as can be seen on Photographs 6 and 7.*	
BRIDGE AND PIERS	*None*	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	*None*	
APPROACH CHANNEL	*None*	
DISCHARGE CHANNEL	*None*	
BRIDGE AND PIERS	*None*	
GATES AND OPERATION EQUIPMENT	*None*	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	*None*	
OBSERVATION WELLS	*None*	
WEIRS	*None*	
PIEZOMETERS	*None*	
OTHER	*None*	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	*Reservoir slopes are steep, densely vegetated and stable.*	
SEDIMENTATION	*As reported by the Chief Operator and Borough Manager, there is no significant sedimentation in the reservoir. An inspection around the reservoir edge did not disclose significant accumulation of sediment.*	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	*The downstream channel is rocky and passes through dense woods to a tunnel approximately 1200 feet downstream. Beyond the tunnel the stream passes into the town of Mount Carbon, Pennsylvania. In the event of dam failure the flood wave would be attenuated by the embankment and the tunnel would control flow. See Photograph 13. This tunnel could be clogged by debris from the woods. The tunnel is 18 feet wide, 18 feet high with a nine foot radius roof passing beneath a four track railroad and multilane highway fill. It is conservatively assumed the railroad/highway embankment would fail if the dam failed.*	
SLOPES	*Side slopes are steep, well vegetated and stable.*	
APPROXIMATE NO. OF HOMES AND POPULATION	*There are no homes along the channel until the stream passes through Mount Carbon, Pennsylvania.*	

APPENDIX

C

LOWER TUMBLING RUN DAM
CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: *Steep, rocky, 100% wooded.*

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): *646.5 (502 Acre-Feet).*

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): *653.0 feet (668 Acre-Feet).*

ELEVATION MAXIMUM DESIGN POOL: *653.0 feet.*

ELEVATION TOP DAM: *653.0 feet.*

SPILLWAY

a. Elevation *646.5 feet.*

b. Type *Rectangular concrete slab in channel cut through rock.*

c. Width *55 feet.*

d. Length *150 feet to drop down hill.*

e. Location Spillover *Left (South) abutment.*

f. Number and Type of Gates *None.*

OUTLET WORKS:

a. Type *Three 12" dia cast iron pipes.*

b. Location *Under center of dam.*

c. Entrance inverts *Approximately 605 feet.*

d. Exit inverts *Approximately 603 feet.*

e. Emergency draindown facilities

HYDROMETEOROLOGICAL GAGES:

a. Type *Recording Rain Gage Station.*

b. Location *Joe Zerbey Airport, 15 miles from dam.*

c. Records *Sent to National Weather Service.*

MAXIMUM NON-DAMAGING DISCHARGE: *5780 cfs. (Capacity of culvert under R.R. tracks with 25 foot head)*

DAM SAFETY ANALYSIS
HYDROLOGIC/HYDRAULIC DATA

Date: 21 Aug. 1978
By: R. H. Cross
Sheet: 2 of 9

DAM Lower Tumbling Run Nat. ID No. PA 00688 DER No. 54-24

	ITEM/UNITS	Permit/Design Files (A)	Calc. from Files/Other (B)	Calc. from Observations (C)
1.	Min. Crest Elev., ft.	652.6		653.0
2.	Freeboard, ft.			0
3.	Spillway(1) Crest Elev, ft.	646.5		
3a.	Secondary(2) Crest Elev, ft.	—		
4.	Max. Pool Elev., ft.			653.0
5.	Max. Outflow(3), cfs	2200		
6.	Drainage Area, mi²	6.5		6.0
7.	Max. Inflow(4), cfs	Failure of Upper Tumb. Run from		inflow >0.3 PMF
8.	Reservoir Surf. Area, Acre	25.5		25.7
9.	Flood Storage(5), ft³ Ac-Ft			166
10.	Inflow Volume, ft³			

Reference all figures by number or calculation on attached sheets:

Example: 3A - Drawing No. xxx by J. Doe, Engr., in State File No. yyyy.

NOTES:

(1) Main emergency spillway.

(2) Secondary ungated spillway.

(3) At maximum pool, with freeboard, ungated spillways only.

(4) For columns B, C, use PMF.

(5) Between lowest ungated spillway and maximum pool.

BY PH Cross DATE 22 Aug 78 SUBJECT Lower Tumbling Run Hydrology & Hydraulics SHEET 3 OF 9

CHKD. BY DATE JOB No

SOURCES - p. 1

1A, 3A, 8A,	Letter report, H.T. Newton of Gilbert Assoc., 1 Mar '67
1C	3A + 8/78 field meas. 6.5 ft
6C	U.S.G.S. Quad Sheet, Pottsville, Pa. (1968)
6A, 5A	Report by C.E. Ryder, 22 Dec '13
4C	Crest of Dam (no fbd)
9C	Surf. Area + 6.5 ft

Note - Drawings & Reports in State File show a variety of elevations, dimensions, etc. Calculations are based on field measurements taken 4 Aug. 1978

- Upper Tumbling Run Dam is about 2600 ft upstream. Max. spillway capacity of U.T.R. is about 2200 cfs, about 1/4 PMF peak inflow. Failure of U.T.R. would result in immediate failure of this dam.

BY RH Cross DATE 22 Aug 78 SUBJECT Lower Tumbling Run - H & H SHEET 4 OF 9

CHKD. BY DATE JOB No

Classification (Ref. Recommended Guidelines for Safety Inspection of Dams)

1. Hazard Classification is HIGH
2. Size Classification is INTERMEDIATE based on height of about 50 ft.
3. Spillway design flood should be PMF based on the above classification

Hydrologic/Hydraulic Analysis

1. Design data was unavailable. Two post-construction inspection reports, by the Water Supply Commission of Pa. dated 22 Dec. 1913, and by Gilbert Associates, Inc., dated 1 Mar. 1967, contain limited hydrologic/hydraulic information. Several drawings on file, many untitled and undated, also contain data on elevations and dimensions, generally conflicting.

1913 Report:
Reservoir Surface Area = 28 Acres
Reservoir Capacity = 173,000,000 gallons
Spillway Width = 58.5 ft
Spillway to Dam Crest = 6 ft
Hydrology done only for upper dam;
Rainfall = 6" in 24 hrs, 100% Runoff.
Drainage Area = 6.5 mi^2
Inflow = 1050 cfs
Max. Stage = 3 ft 7 in above spillway
Freeboard = 2 ft 5 in. (below crest)
Max Spillway capacity = 2200 cfs

1967 Report

Crest Elev. = 652.6 ft
Storage = 163,700,000 gal
Spillway elev = 646.5 ft
Spillway width = 56 ft
Max Spillway capacity = 2100 cfs

Using $Q = C L H^{3/2}$ with $C = 2.5$ for the very rough & irregular spillway gives
$Q = 2.5 \times 55 \times 6.5^{3/2} = 2278.6$ cfs ≈ 2200

USE 2200 cfs

From the U.S.G.S. Topographic map, the drainage area was found to be 6.0 mi^2, with 5.5 mi^2 tributary also to Upper T. R. Dam.

Spillway elevation from the most recent report was accepted, and crest elevation found by adding the elev. difference measured in the field. (Sheets I & II)

2. Effect of Upper Tumbling Run Dam:

PMF for Upper T.R., as instructed by the Corps of Engineers* by comparison with West Br. Schuylkill River, is

$$PMF = 7200\left(\frac{55.5}{A \cdot L}\right)^{0.8} = 8028 \text{ cfs}$$

Spillway Capacity = 2200 cfs (1913 Report)

PMP 25.5 inches for 10 mi^2, 6-hr duration (U.S.W.B, TP-40)
Use 90% runoff = 22.95 in.

Inflow vol. $V_2 = 22.95/12 \times 5.5 \times 640$
$= 6732$ Acre-ft.

Storage = 35.55 Ac × 6.2 ft = 220 Acre-ft.

*Baltimore District

For PMF: [Ref: Sheets 8 & 9]

$$\frac{Q_o}{Q_I} = \frac{2200}{8028} = 0.274 = p$$

Storage Req. = V_e

$$V_e = (1-p)\,V_I = (1-.274)\cdot 6732$$

$$= 4887 \text{ Ac-ft} >> 220 \text{ Ac-ft.}$$

For 50% PMF

$$\frac{Q_o}{Q_i} = \frac{2200}{4014} = 0.548$$

$$V_e = (1-0.548)\times 3366$$

$$= 1521 \text{ Ac-ft} >> 220 \text{ Ac-ft}$$

For 30% PMF

$$\frac{Q_o}{Q_I} = \frac{2200}{2408} = 0.913$$

$$V_e = (1-.913)\cdot(.3\times 6732)$$

$$= 176 \text{ Ac-ft} \approx 220 \text{ Ac-ft} \quad \underline{OK}$$

∴ INFLOW OVER 30% OF PMF WILL CAUSE UPPER TUMBLING RUN TO OVERTOP, AND PRESUMABLY FAIL.

Capacity of Upper T.R. with water at dam crest is 1045 Ac-ft.
With Lower T.R. reservoir at spillway crest, remaining storage is 668-502 = 166 Ac-ft; Assuming failure is rapid, the available storage is only about 1/6 the inflow volume, and thus Lower T.R. Dam is massively overtopped, and Fails.

3. DOWNSTREAM:

Approximately 1200 ft downstream, the valley is blocked by an abandoned multiple-track railroad embankment. At the embankment, the stream passes through a culvert; the downstream portion of the culvert is 18 ft wide by 10 ft high, and the top of the embankment is about 35-40 ft above the channel invert.

From the U.S.G.S. Topographic map "Pottsville, Pa", the storage upstream from the embankment is less than a quarter of the capacity of Lower Tumbling Run.

THUS FAILURE OF LOWER TUMBLING RUN DAM WOULD CAUSE MASSIVE FLOODING OF MOUNT CARBON.

Non-damaging downstream discharge: Assume valley upstream of culvert can take flooding to 2.5 ft over culvert center, with ~ no damage. Smallest X-section is downstream, under highway, approx. 10 × 18 ft.

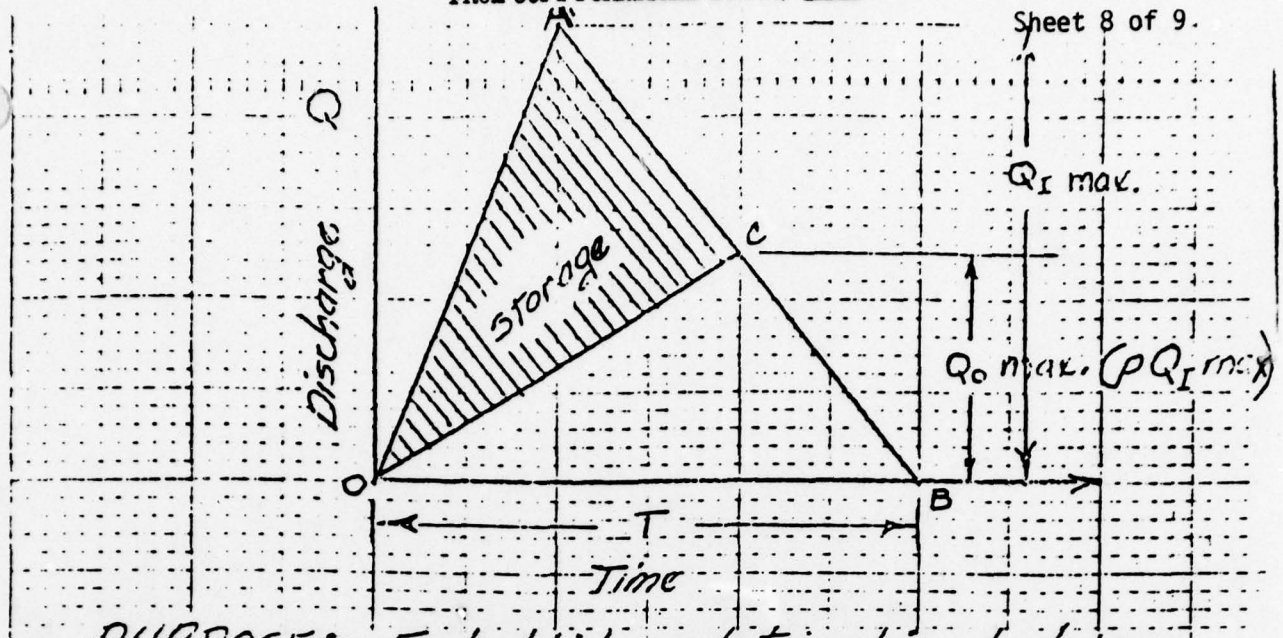
Area ~ 18×10 = 180 ft

Head = 25 ft (neglecting tailwater effects)

C_c est. at 0.8 as ent. is from larger culvert

$$Q = C_c A \sqrt{2gH} = 0.8 \times 180 \times \sqrt{2 \times 32.2 \times 25}$$

$$= 5778 \text{ cfs}$$



PURPOSE: Establish relationship between maximum spillway discharge and storage required to pass flood hydrograph without exceeding maximum pool level.

$$\frac{\Delta AOC}{\Delta AOB} = \frac{\Delta AOB - \Delta COB}{\Delta AOB} = 1 - \frac{\Delta COB}{\Delta AOB}$$

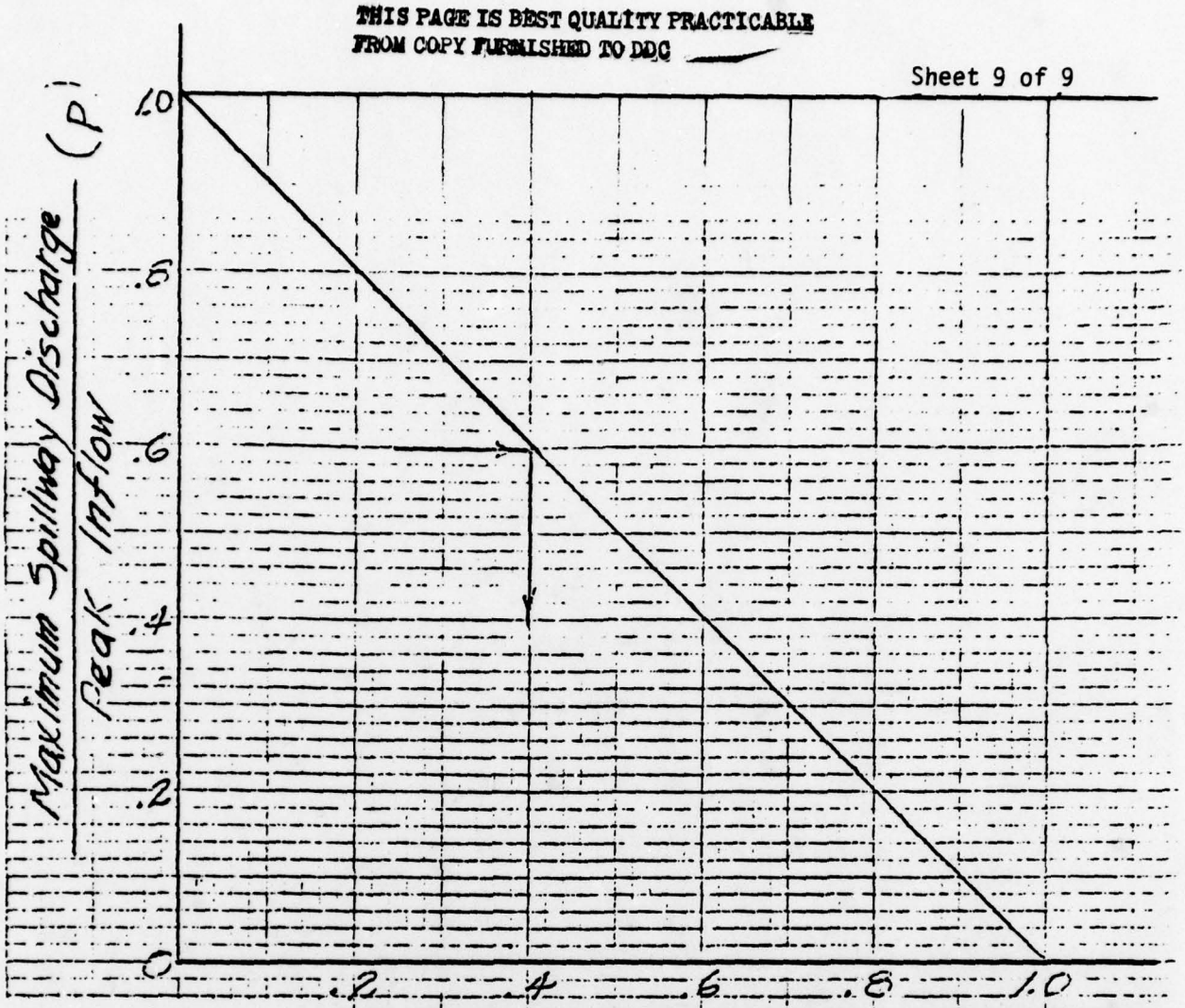
$$\frac{\Delta AOC}{\Delta AOB} = 1 - \frac{T\,pQ_I\,max/2}{T\,Q_I\,max/2} = 1 - p$$

$$\Delta AOC = (1-p)\,\Delta AOB \quad \text{where } 0 \le p \le 1.0$$

p	Δ AOC
1.00	0
0.75	0.25 Δ AOB
0.50	0.50 Δ AOB
0.25	0.75 Δ AOB
0	1.00 Δ AOB

REFERENCE

PRELIMINARY ENGINEER TECHNICAL LETTER NO. 1110-2-
25 January 1978

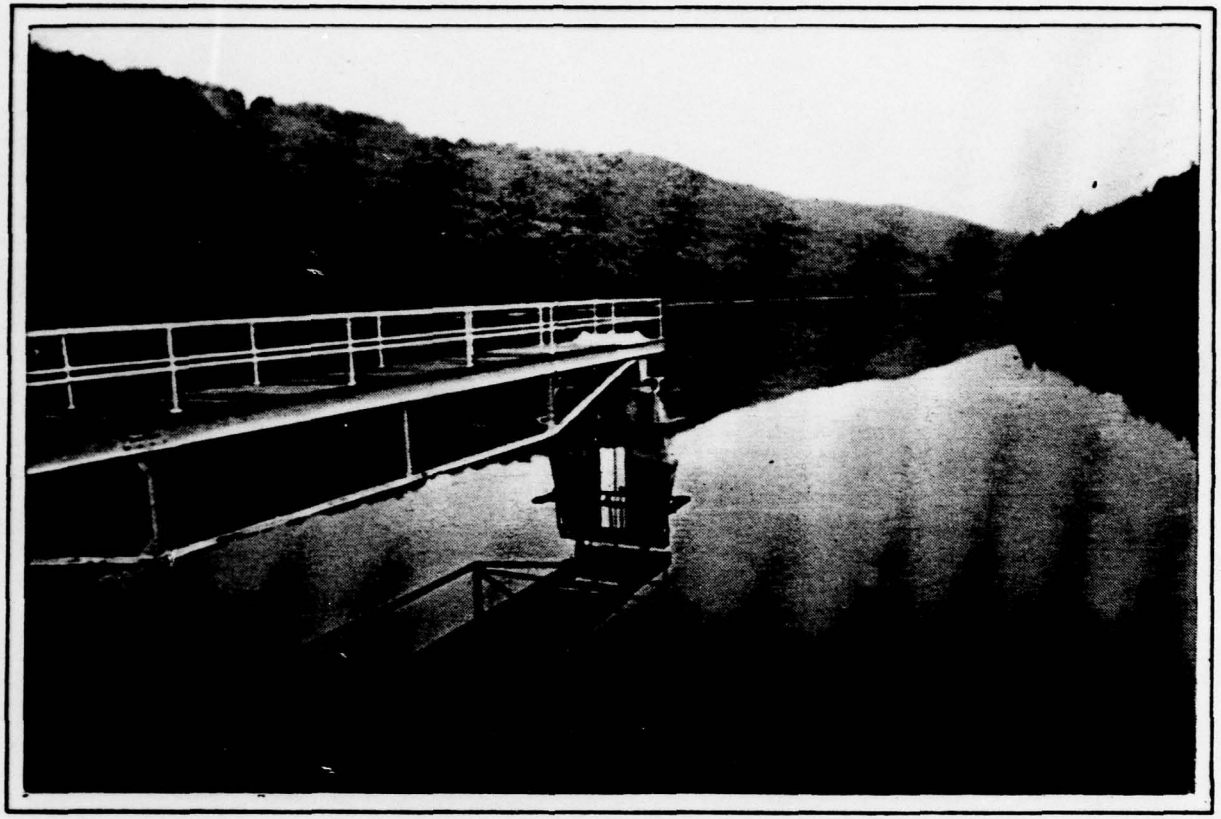


Steps to obtain required reservoir to pass inflow hydrograph without overtopping dam.

1. Obtain maximum spillway discharge
2. Develop inflow hydrograph
3. Compute relationship of maximum spillway capacity to peak inflow
4. Read relationship of required reservoir storage to volume of inflow hydrograph from curve

APPENDIX

D

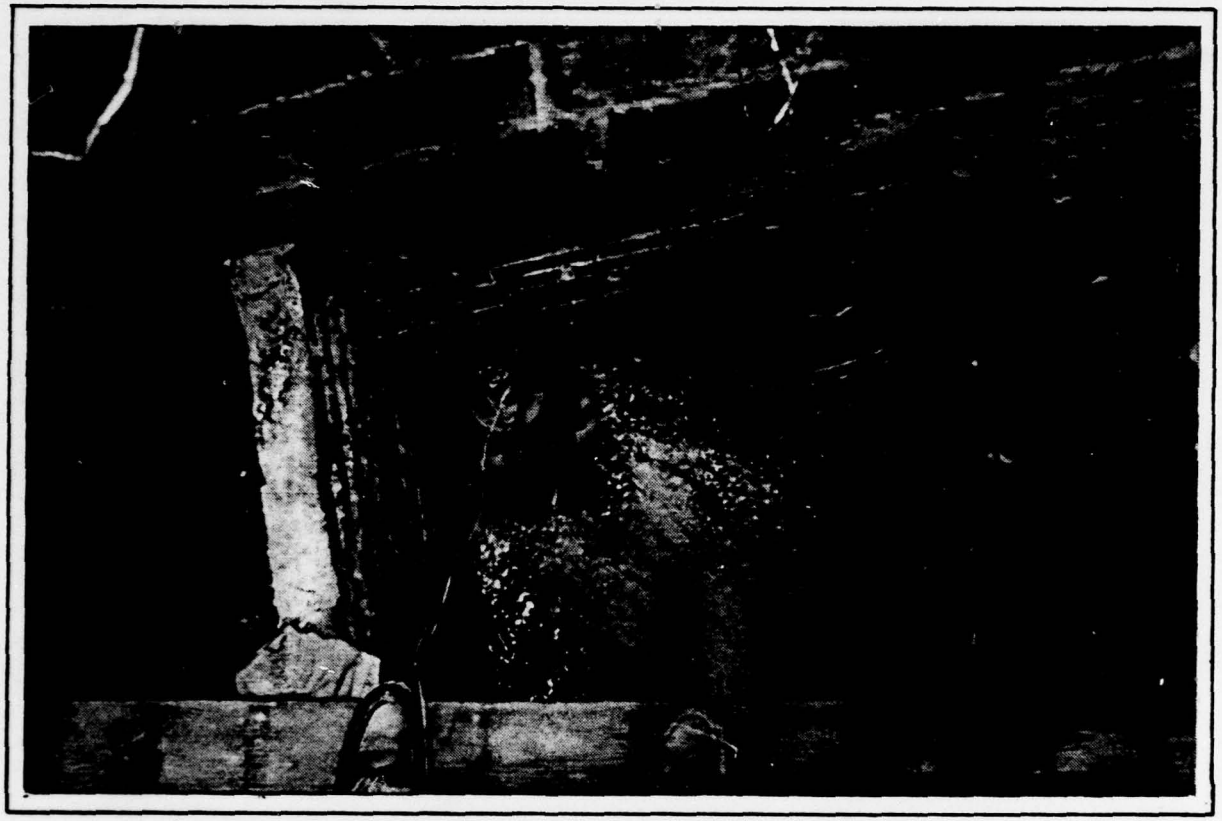


OUTLET SUPPLY CONTROL TOWER AND
ACCESS BRIDGE.

PHOTOGRAPH NO. 1

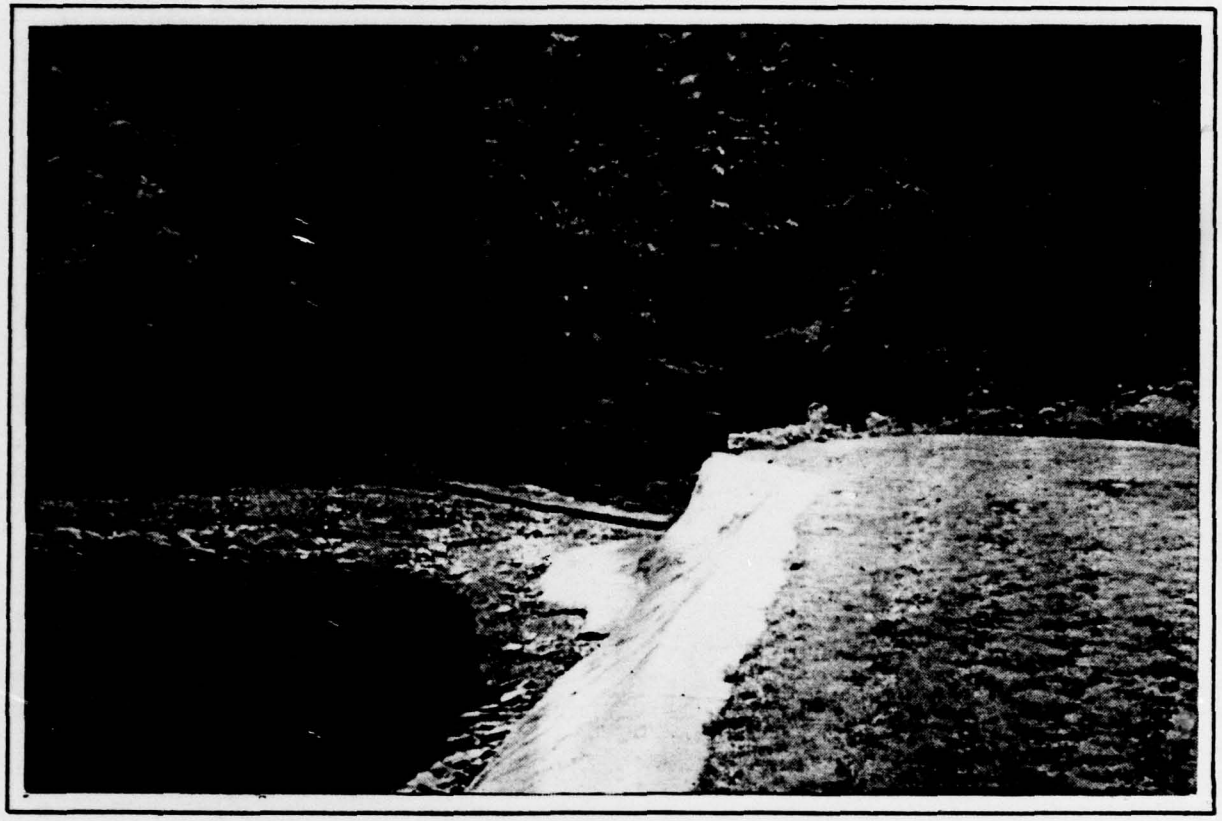
VIEW OF TUNNEL AT DOWNSTREAM TOE
THROUGH WHICH THREE WATER SUPPPLY
PIPES PASS. VALVE HOUSINGS CAN
BE SEEN IN FOREGROUND.

PHOTOGRAPH NO. 2



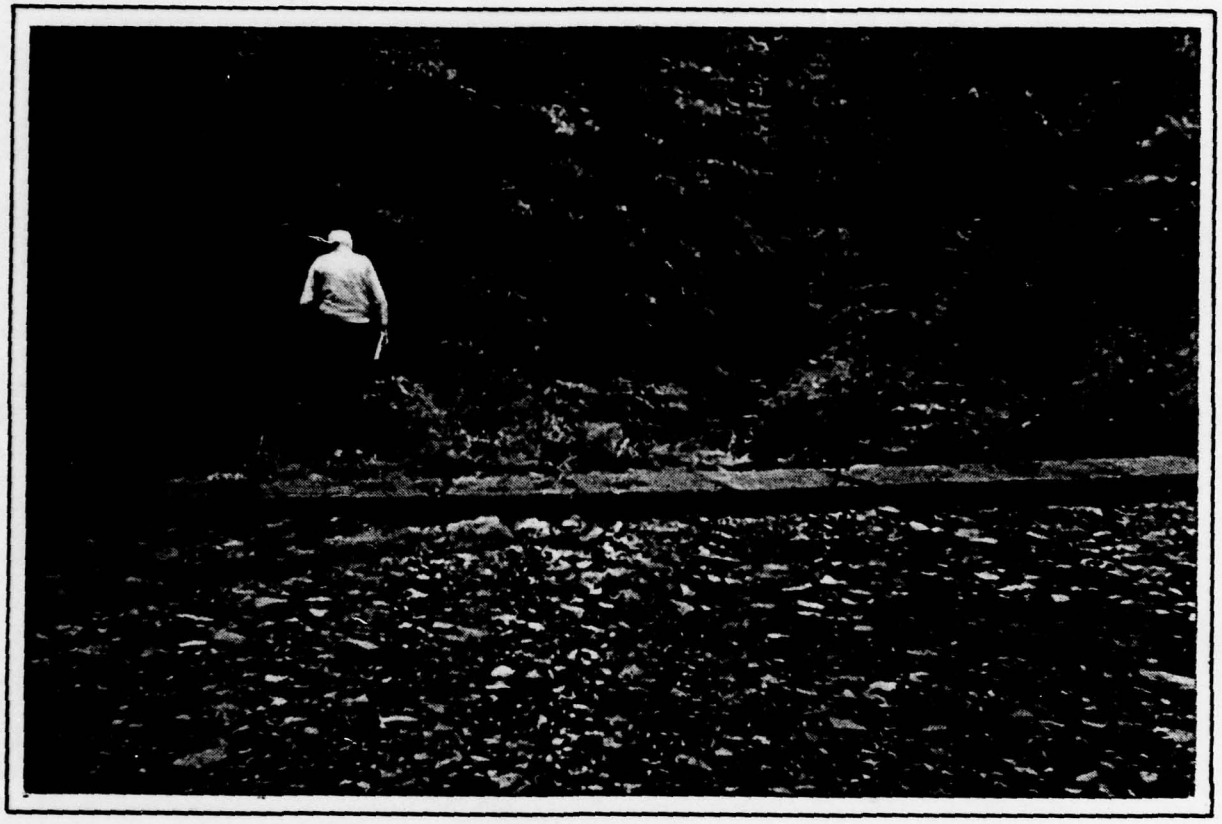
CONTROL VALVES FOR WATER SUPPLY
PIPES.

PHOTOGRAPH NO. 3



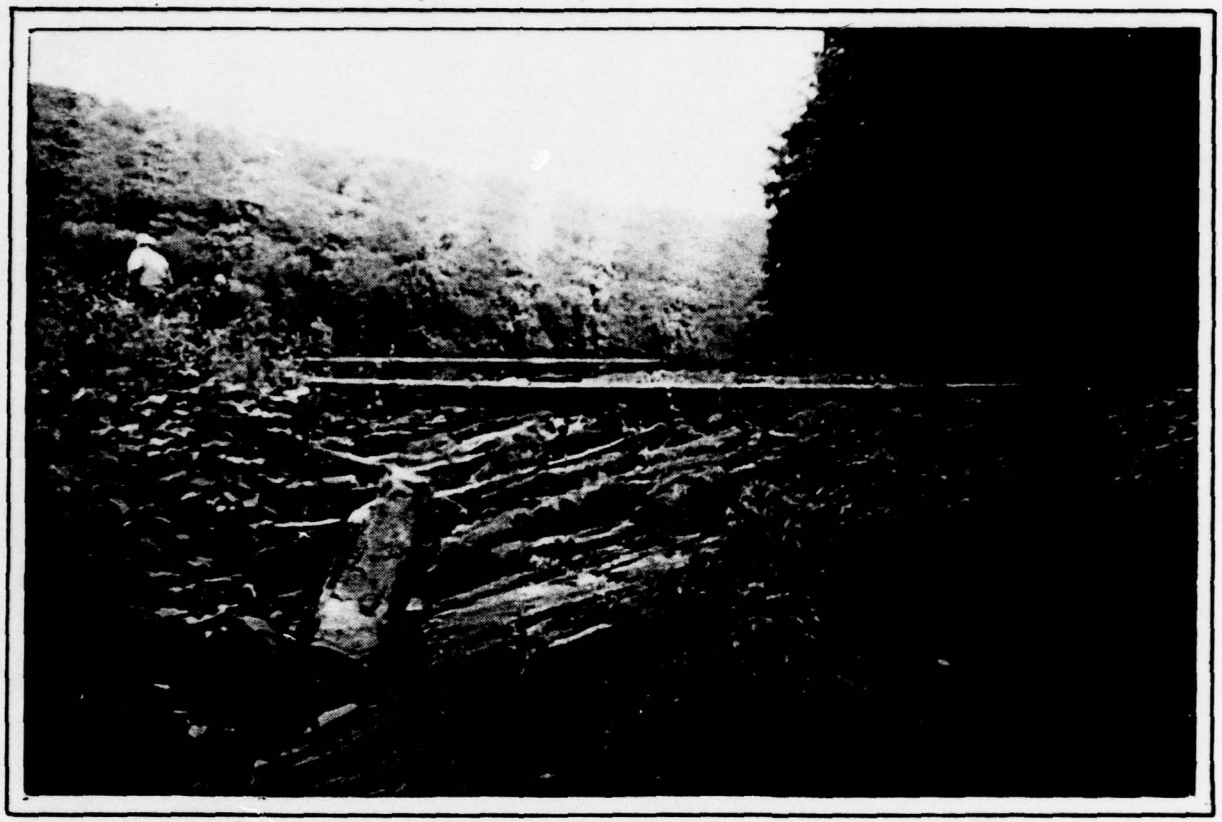
VIEW OF SPILLWAY APPROACH CHANNEL
AND BROAD CRESTED WEIR.

PHOTOGRAPH NO. 4

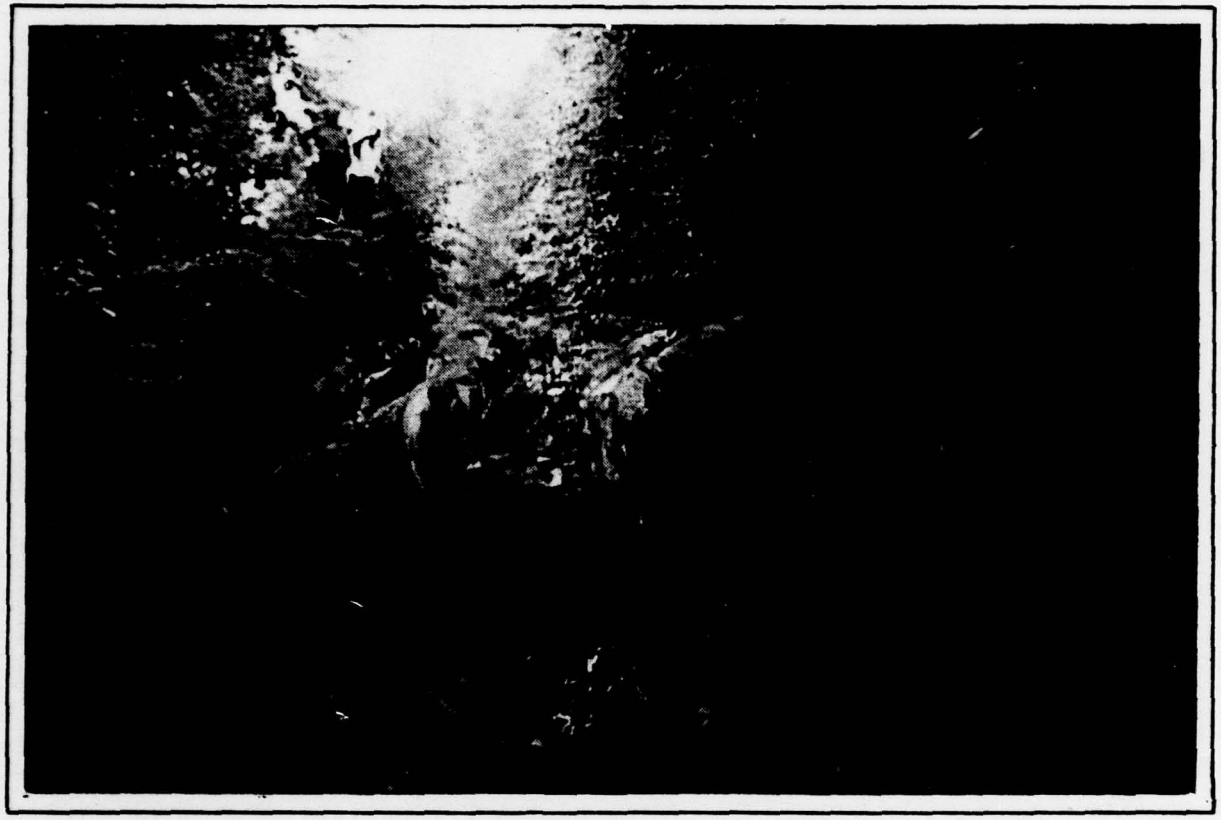


VIEW LOOKING DOWNSTREAM THROUGH SPILLWAY. NOTE BROAD CRESTED WEIR.

PHOTOGRAPH NO. 5



VIEW LOOKING UPSTREAM TOWARDS
SPILLWAY CONTROL SECTION.

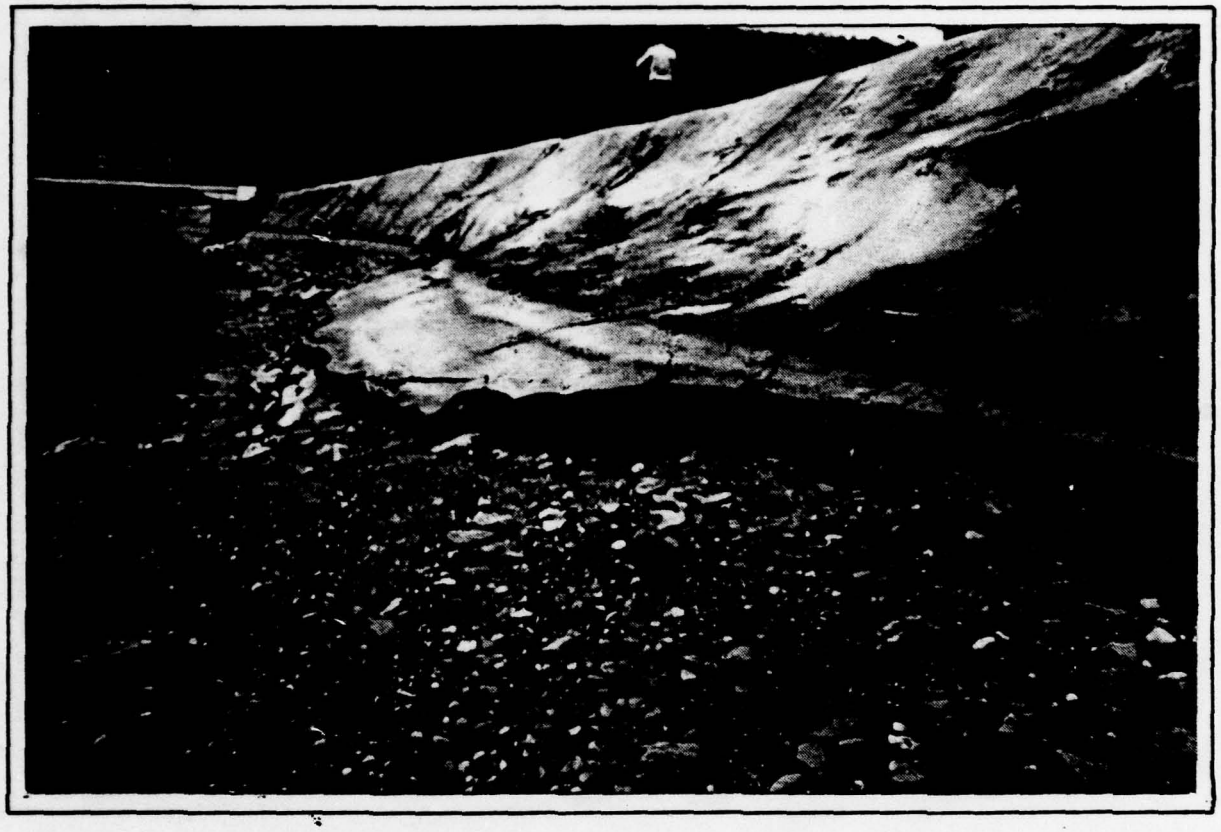


VIEW LOOKING UPSTREAM TOWARDS END OF SPILLWAY CHANNEL. NOTE CHANNEL DETERIORATION.

PHOTOGRAPH NO. 7

END OF SPILLWAY CHANNEL LOOKING
DOWNSTREAM INTO THE NATURAL
STREAMBED.

PHOTOGRAPH NO. 8



VIEW OF UPSTREAM RIPRAP SPRAYED WITH GUNITE. NOTE EROSION AT BASE OF RIP-RAP.

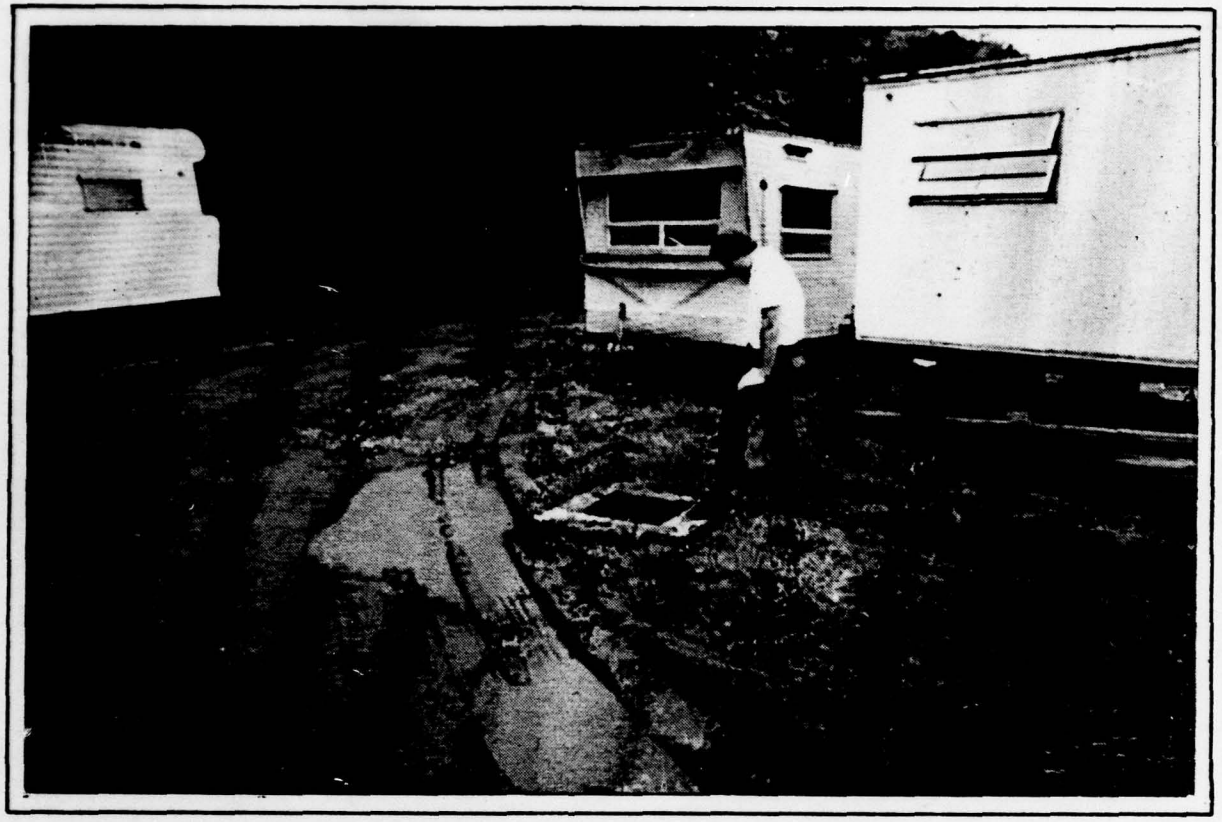
PHOTOGRAPH NO. 9

VIEW OF ACCESS BRIDGE ABUTMENT ON EMBANKMENT. NOTE CRACKS AND OVERALL DETERIORATION.

PHOTOGRAPH NO. 10

OVERVIEW OF DOWNSTREAM EMBANKMENT SLOPE. NOTE VEGETATION AND STEEPNESS OF SLOPE.

PHOTOGRAPH NO. 11



ACCESS BOX TO TOE DRAIN SEEPAGE.
THE EMBNAKMENT IS ON THE LEFT
OF THE PHOTOGRAPH.

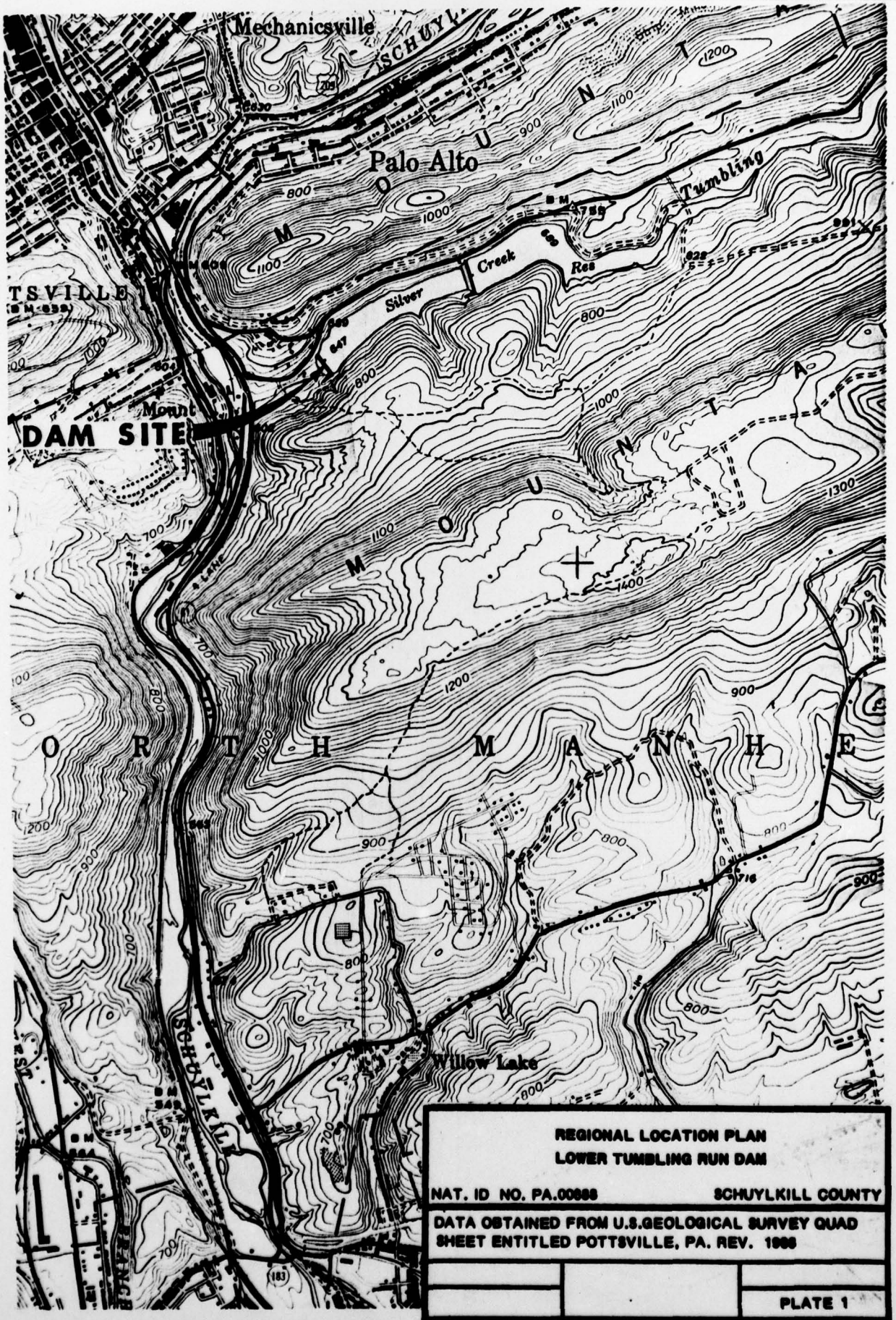
PHOTOGRAPH NO. 12

TUMBLING RUN CREEK PASSES THROUGH A TUNNEL UNDER A COMBINED 4-TRACK RAILROAD SIDING AND MULTILANE HIGHWAY DOWNSTREAM OF THE DAMS.

PHOTOGRAPH NO. 13

APPENDIX

E

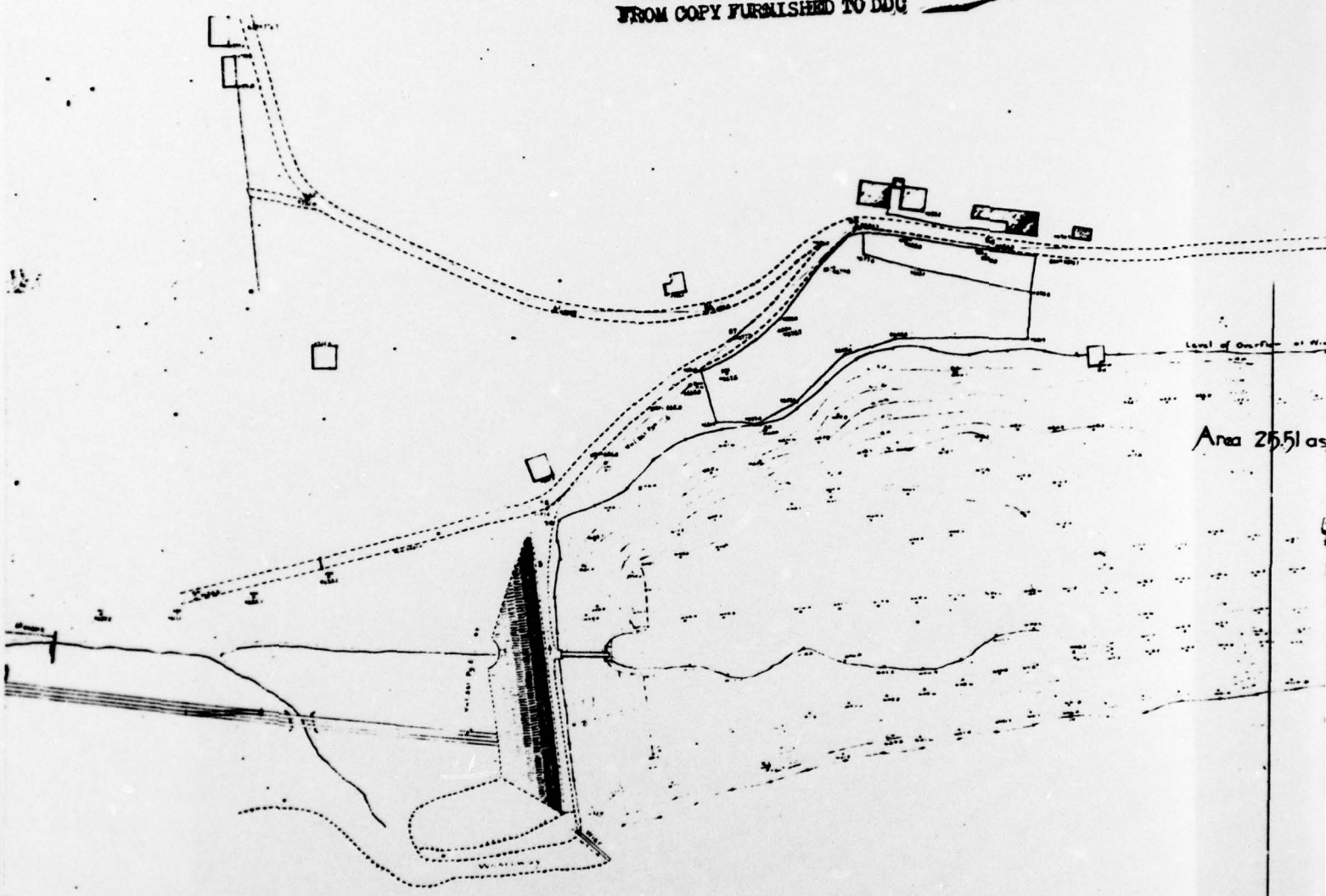


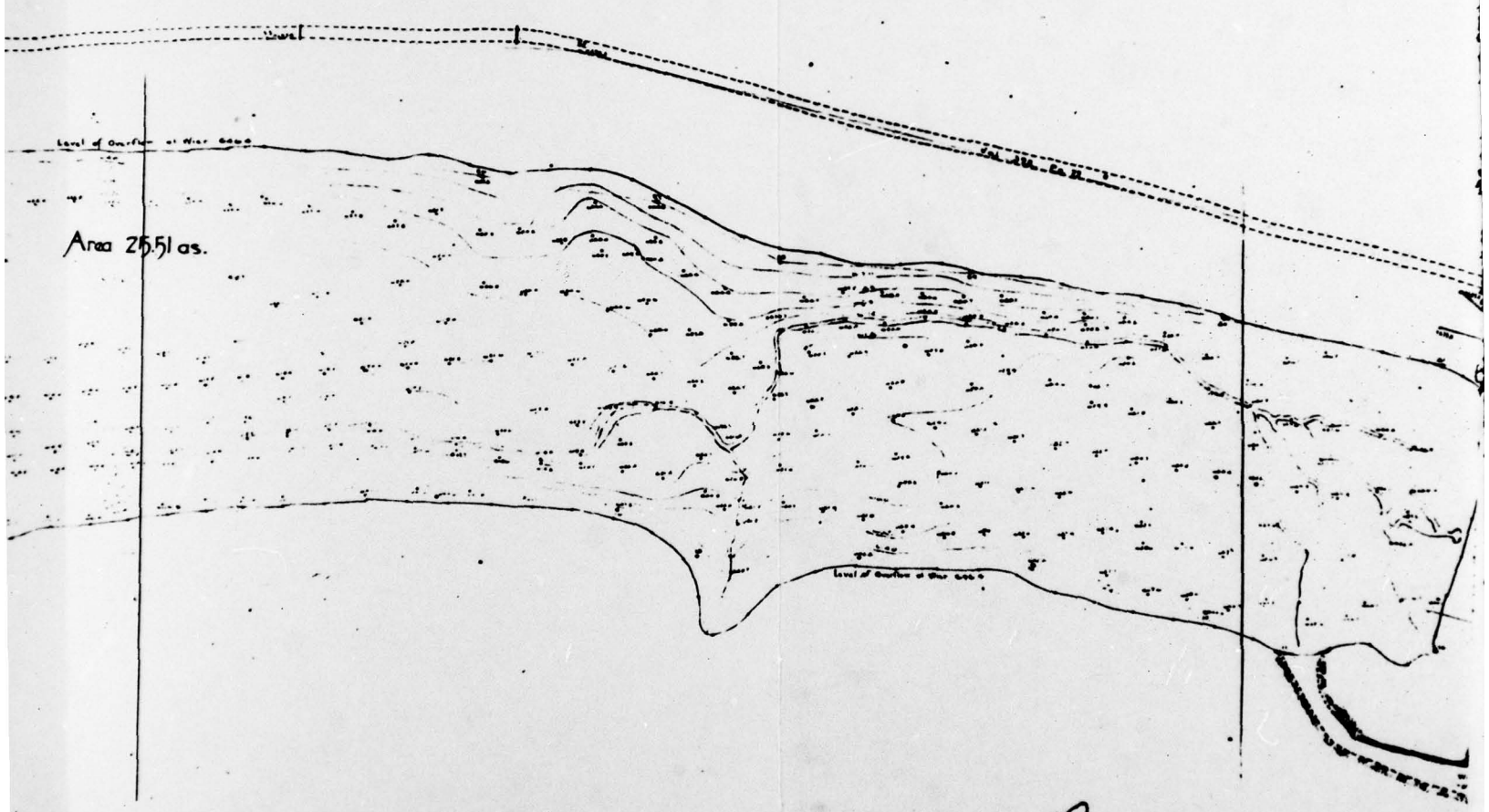
REGIONAL LOCATION PLAN
LOWER TUMBLING RUN DAM

NAT. ID NO. PA.00888 SCHUYLKILL COUNTY

DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY QUAD SHEET ENTITLED POTTSVILLE, PA. REV. 1966

PLATE 1





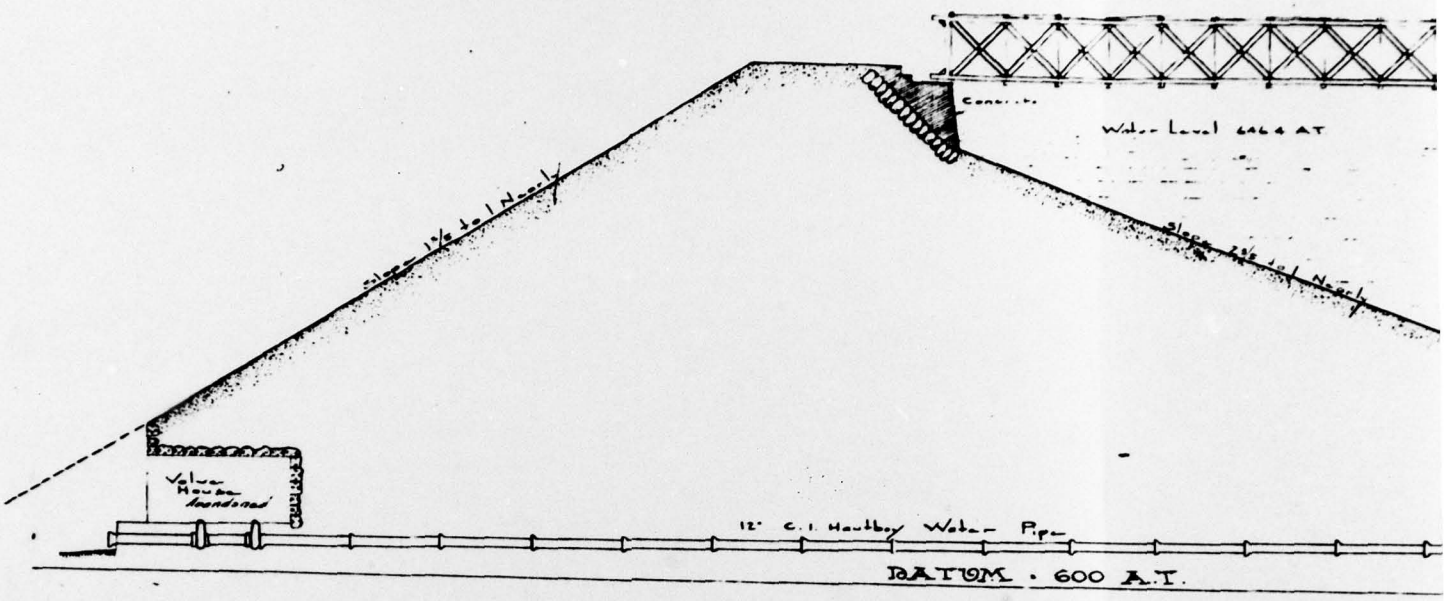
2

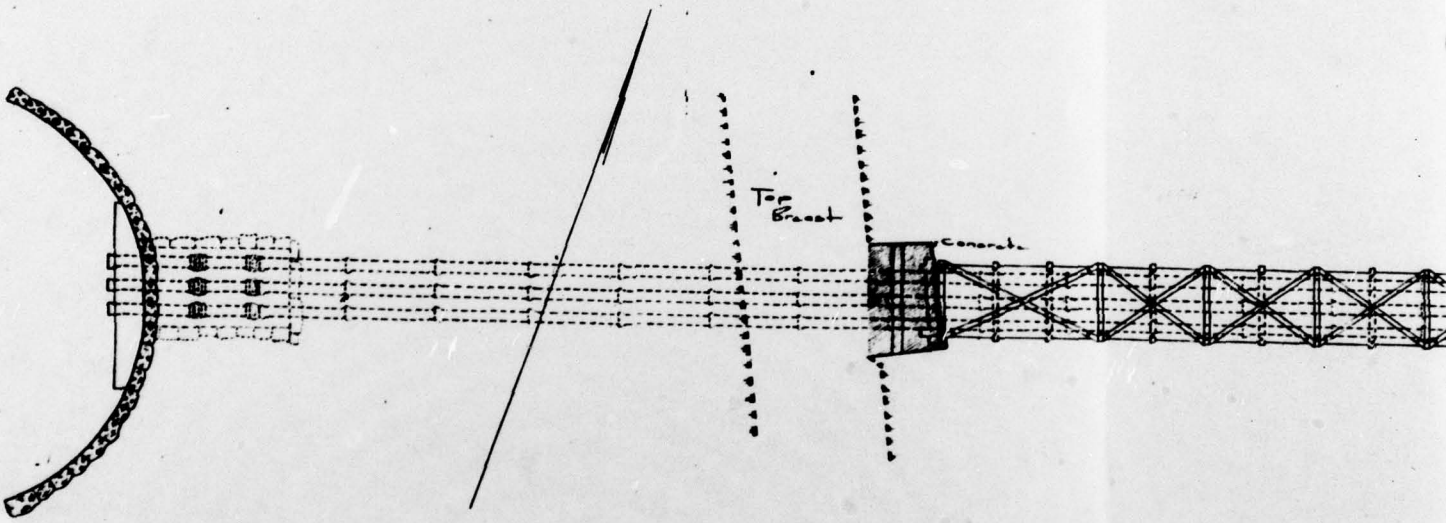
PLAN OF DAM & APPURTENANCES
LOWER TUMBLING RUN DAM

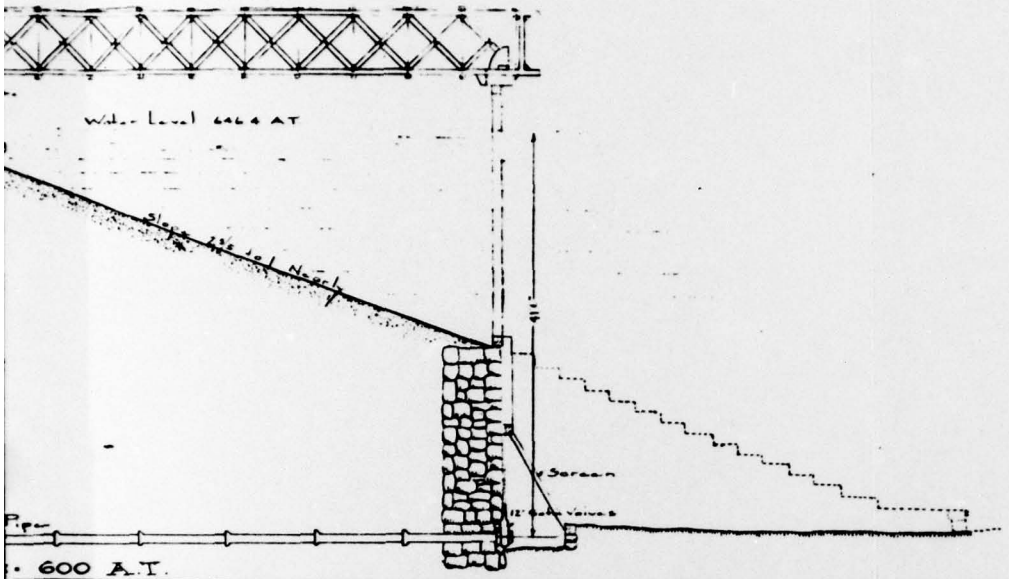
NAT. ID NO. PA.00688 SCHUYLKILL COUNTY

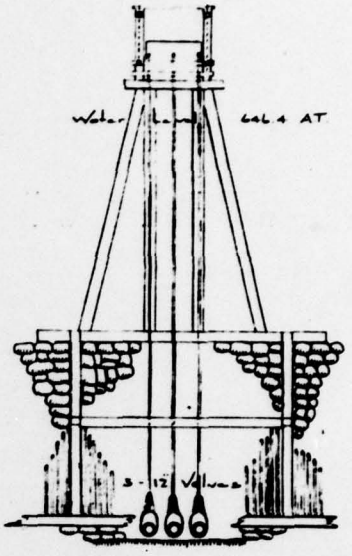
DATA OBTAINED FROM DEPARTMENT OF ENVIROMENTAL RESOURCES, HARRISBURG, PA.

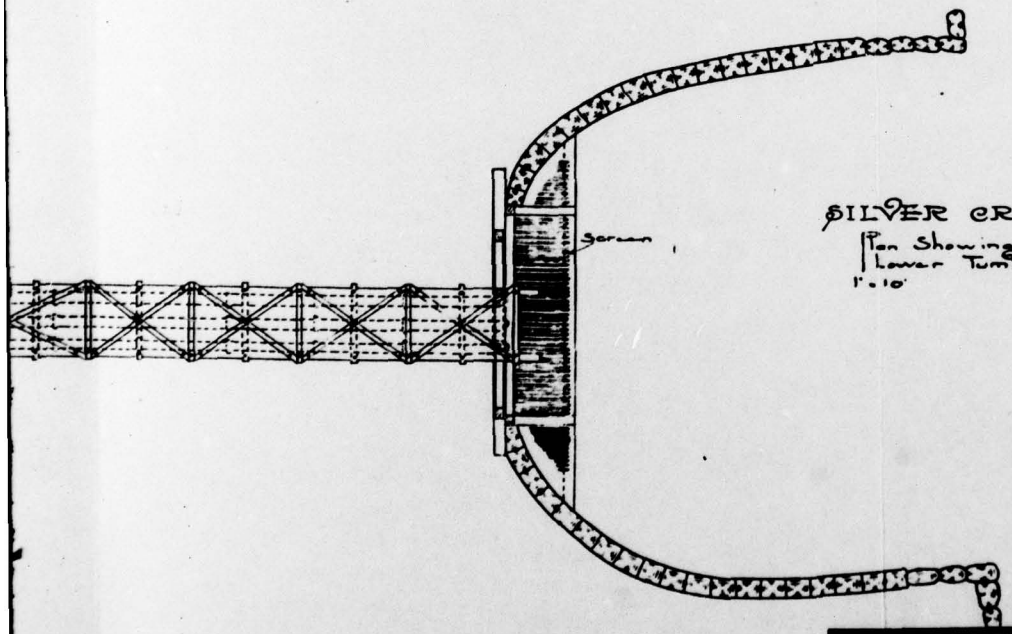
PLATE 2











SILVER CREEK WATER CO.
Plan Showing Valves and Outlet at Lower Tumbling Run Reservoir.
1" = 10'
Pottsville, Pa. Aug 6 1908

2

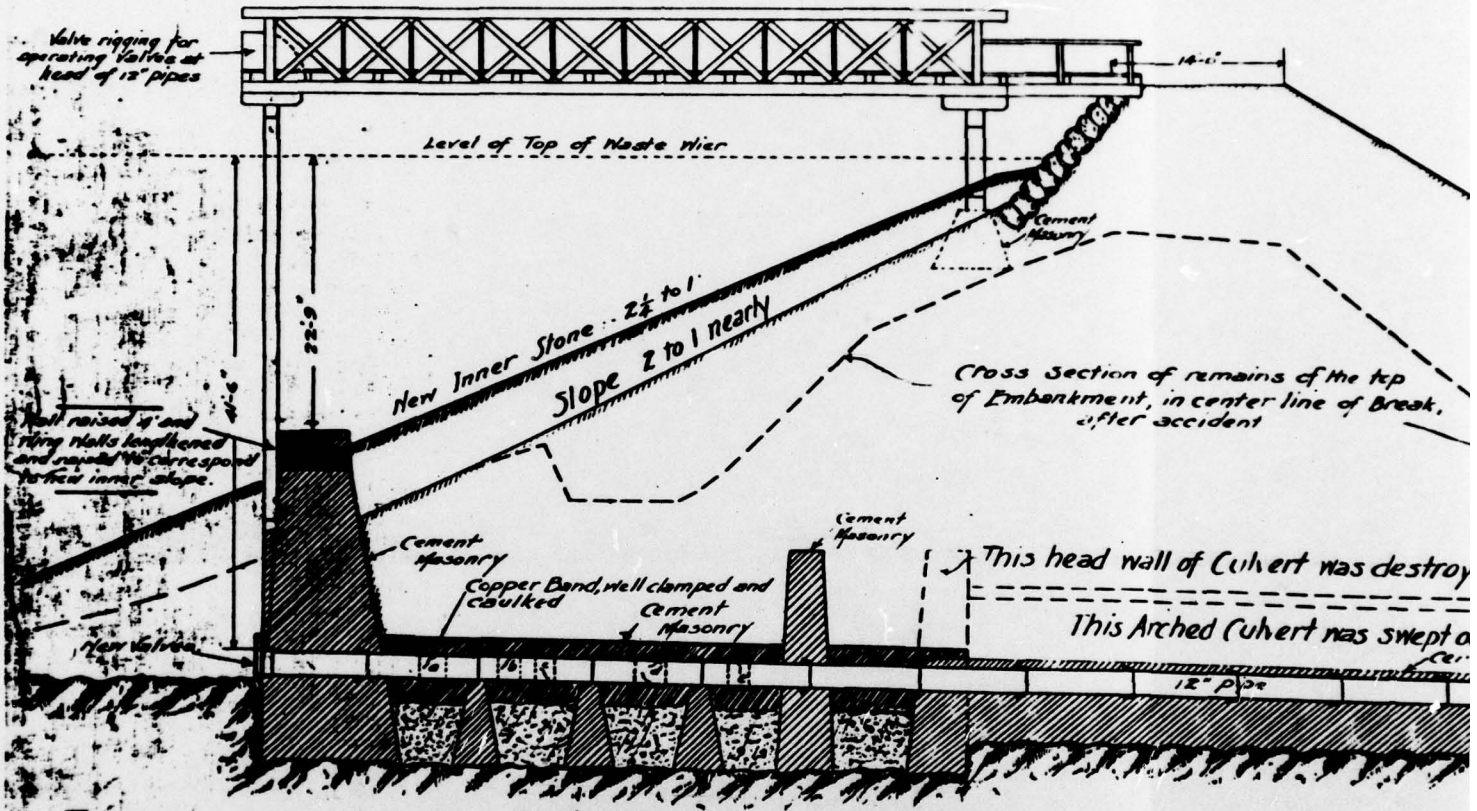
TYPICAL CROSS SECTION OF DAM
LOWER TUMBLING RUN DAM

NAT. ID NO. PA.00688 **SCHUYLKILL COUNTY**

DATA OBTAINED FROM DEPARTMENT OF ENVIROMENTAL RESOURCES , HARRISBURG, PA.

PLATE 3

CRO



There were a number of cracks in the pipe (a, b, c, d, e) which were banded, clamped and caulked in the very best manner before building the cement wall around the pipes.

Underneath the pipe was soft Clay puddles — this is now dug out 2 ft. below pipes and under this for .5 ft. more in depth the Clay has been consolidated to a good building foundation by ramming pebbles and broken stone and working it down with an iron puddle bar. Pipes are now covered with cement wall shown in Red.

TUMBLING RUN RESERVOIR

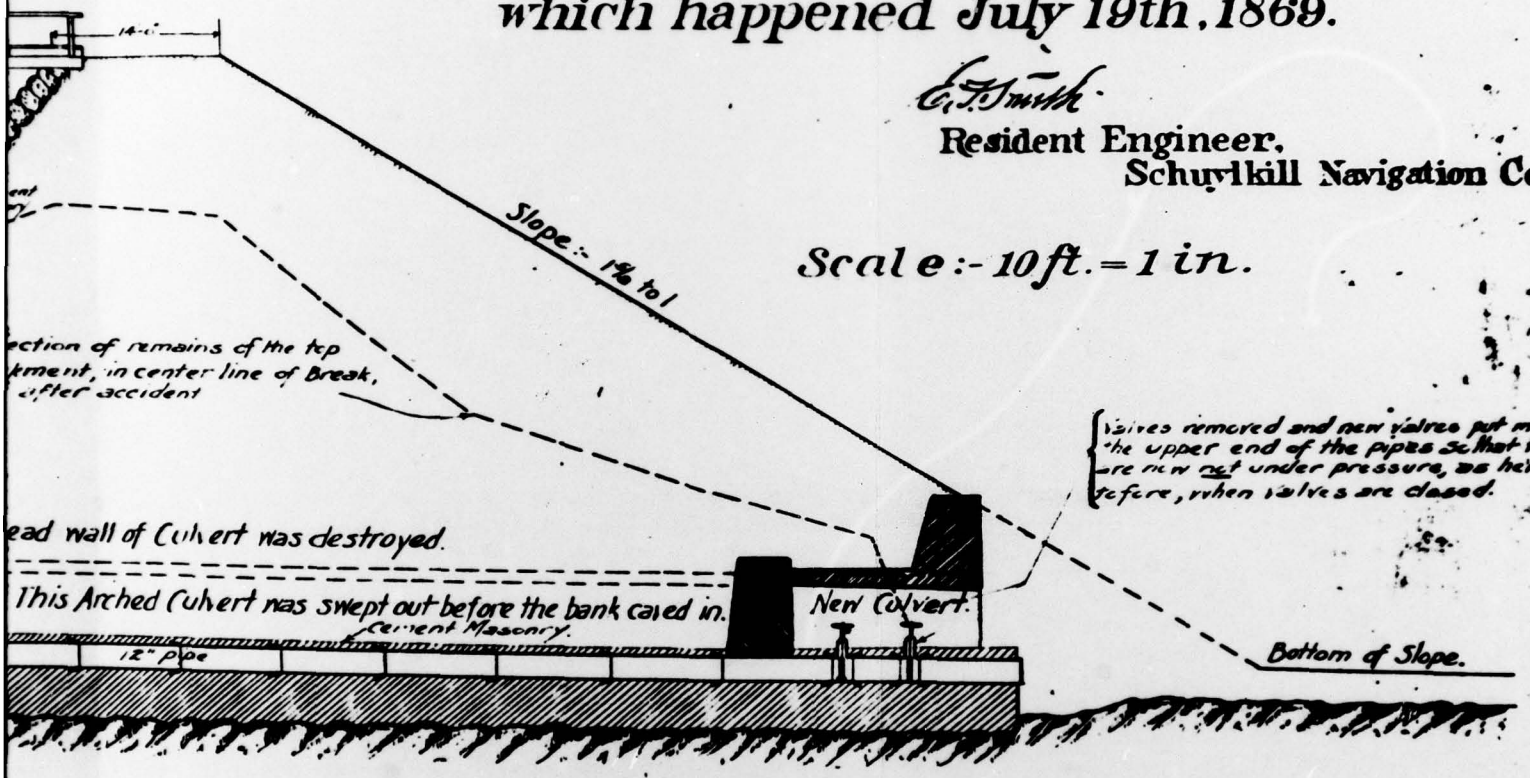
CROSS SECTION OF EMBANKMENT

SURVEY made after Accident.

which happened July 19th, 1869.

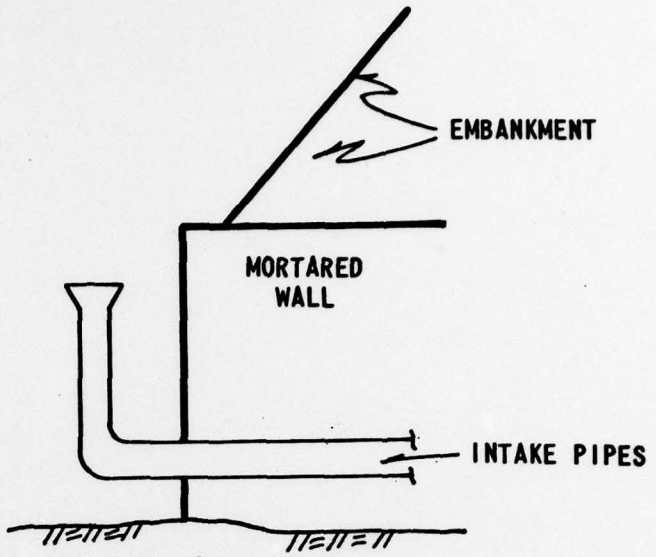
E. F. Smith.
Resident Engineer,
Schuylkill Navigation Co.

Scale:- 10 ft. = 1 in.

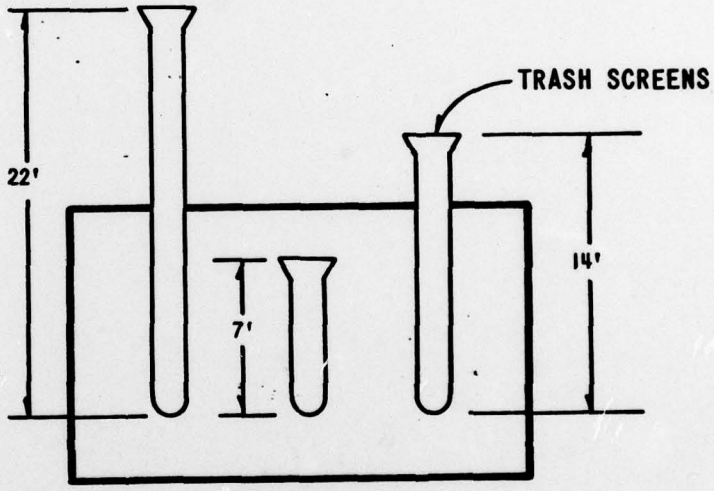


2

TYPICAL CROSS SECTION OF EMBANKMENT LOWER TUMBLING RUN DAM		
NAT. ID NO. PA.00688		SCHUYLKILL COUNTY
DATA OBTAINED FROM DEPARTMENT OF ENVIROMENTAL RESOURCES, HARRISBURG, PA.		
		PLATE 4



SIDE VIEW
(NO SCALE)



FRONT VIEW
LOOKING DOWNSTREAM
(NO SCALE)

SECTION OF WATER SUPPLY INTAKE STRUCTURE LOWER TUMBLING RUN DAM		
NAT. ID NO. PA.00688		SCHUYLKILL COUNTY
DATA OBTAINED FROM VERBAL REPORTS FROM THE OWNER		
		PLATE 5

APPENDIX

F

SITE GEOLOGY
LOWER TUMBLING RUN DAM

Lower Tumbling Run Dam is located in the Appalachian Mountain Section of the Valley and Ridge Physiographic Province. The bedrock at the dam site is reported to consist of the red and brown sandstones, siltstones, and shales of the Mauch Chunk Formation (see Plate F-1). To the north, the Mauch Chunk Formation is bounded by the sandstones, shales and coal of the Pennsylvanian Pottsville and Llewellyn Formations, and to the south the Mauch Chunk Formation is bounded by the sandstones, siltstones, and shales of the Mississippian, Pocono and the Devonian Catskill Formation (Wood, 1973). Bedding is overturned, striking to the east-northeast and dipping steeply to the south-southwest (Wood, 1973). Two dominant sets of open, variably spaced joints have been observed: one set oriented along the strike of bedding, dipping gently to the northwest, and a second set striking north-northwest, and dipping steeply to the west (Wood, 1973; Sevon, 1975). No faults have been mapped beneath the dam, although two faults, one on either side of the reservoir, have been reported striking parallel to the reservoir.

Pleistocene age deposits are very limited in the dam site area, and are reported to mainly consist of periglacial talus deposits that cover much of the Tumbling Run stream valley (Wood, 1973).

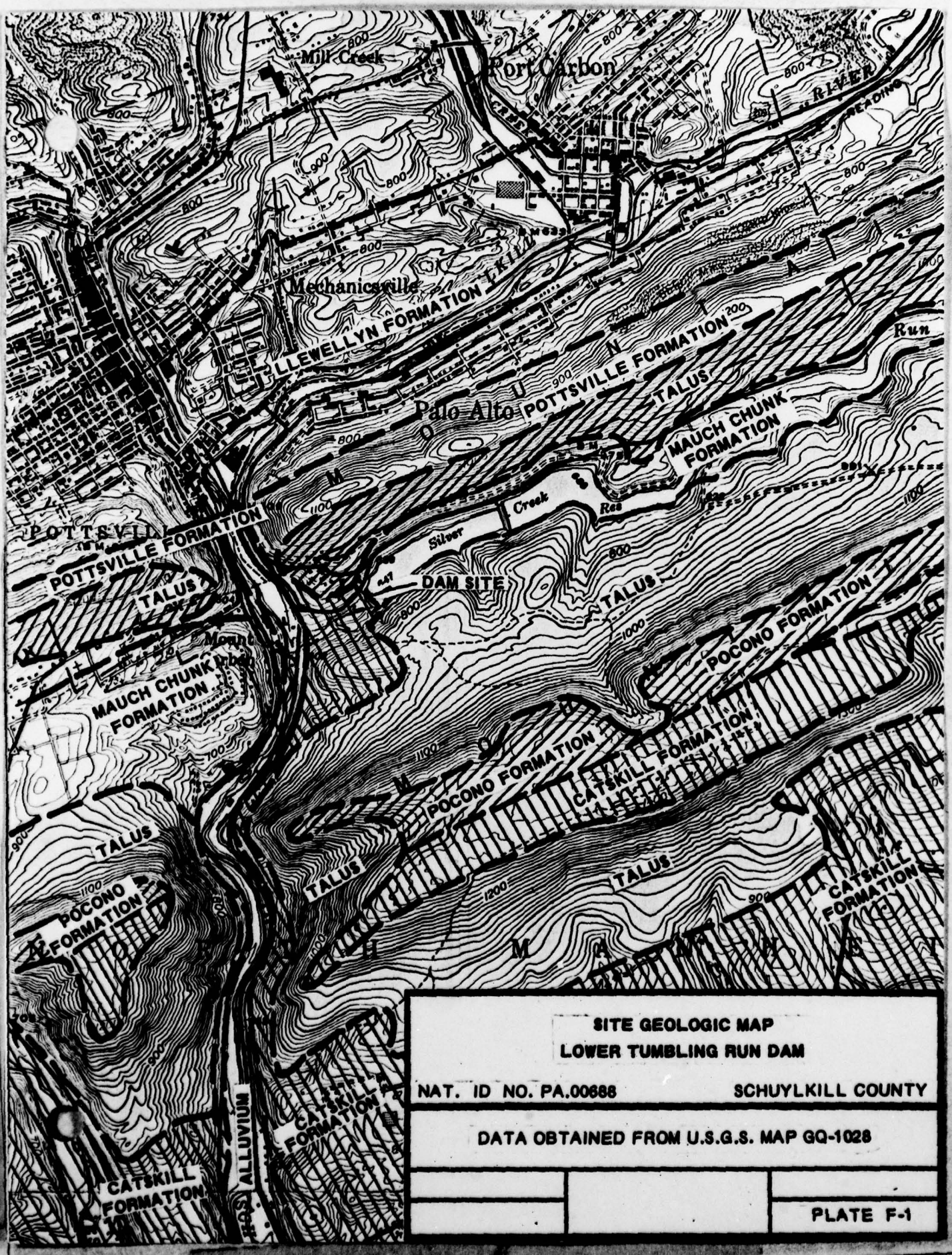
Downstream seepage should not be a major problem unless the major east-northeast joint set is well developed, and is a zone of groundwater transport, beneath the dam due to the dam being constructed perpendicular to these features.

References:

1. *Sevon, W.D., 1975, Geology and Mineral Resources of the Christmans and Pohopoco Mountain Quadrangle Carbon and Monroe Counties, Pennsylvania: Pa. Geol. Survey Atlas 195 ab, Plate 1, 1:24,000.*

2. *Willard, Bradford, 1939, Guide to the Geology of the Upper Schuylkill Valley: Pa. Geol. Survey, 4th Series, Bull. 1939, 24 p.*

3. *Wood, G.H., 1973, Geologic Map of the Pottsville Quadrangle, Schuylkill County, Pennsylvania: USGS Geologic Map GQ1028, 1:24,000.*

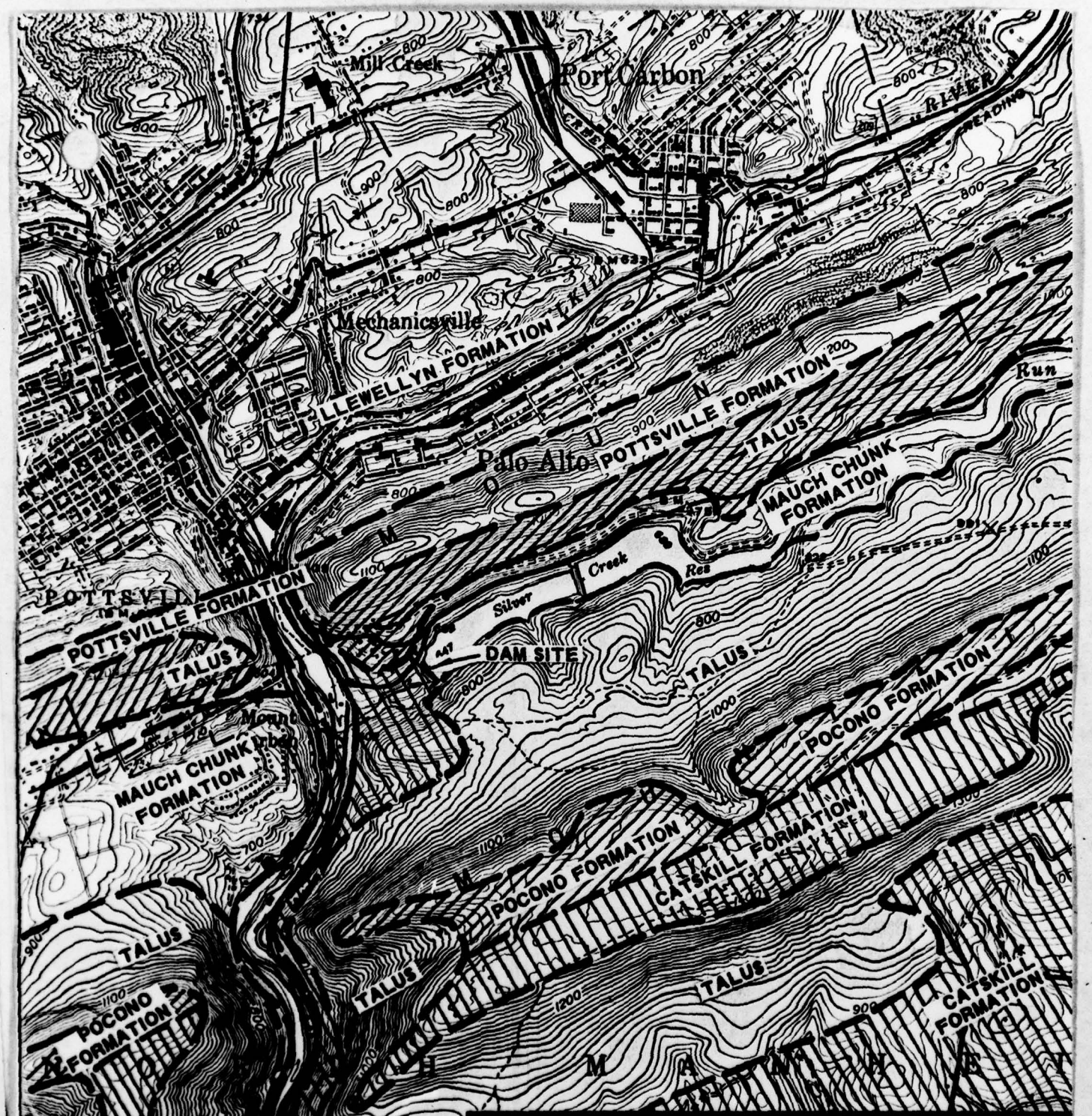


SITE GEOLOGIC MAP
LOWER TUMBLING RUN DAM

NAT. ID NO. PA.00688 SCHUYLKILL COUNTY

DATA OBTAINED FROM U.S.G.S. MAP GQ-1028

PLATE F-1



SITE GEOLOGIC MAP
LOWER TUMBLING RUN DAM

NAT. ID NO. PA.00688 SCHUYLKILL COUNTY

DATA OBTAINED FROM U.S.G.S. MAP GQ-1028

PLATE F-1